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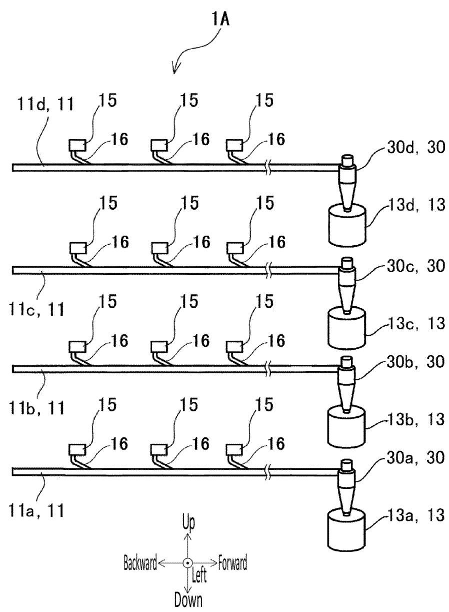
(54) FALSE-TWISTING MACHINE AND FIBER WASTE COLLECTION DEVICE

(57) [Problem to be Solved] Provided is a false-twisting machine and fiber waste collection device configured to separate fiber waste from air appropriately thereby capable of suppressing the discharge of the fiber waste to an exterior thereof.

[Solution to Problem] In a false-twisting machine, a fiber waste collection device 1 configured to collect fiber waste includes: a fiber waste transfer pipe 11 through which the suctioned fiber waste is transferred; a fiber waste collection unit 13 for collecting therein the fiber waste transferred through the fiber waste transfer pipe 11; a cyclone separator 30 configured to separate the fiber waste from air transferred through the fiber waste transfer pipe 11 so as to collect the separated fiber waste in the fiber waste collection unit 13; and an air discharge unit connected to the cyclone separator 30 for discharging the air obtained after having been separated from the fiber waste, wherein the fiber waste transfer pipe 11 includes a plurality of fiber waste transfer pipes, and the cyclone separator 30 includes a plurality of cyclone separators each arranged to each of the plurality of fiber waste transfer pipes 11.

FIG. 9



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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a false-twisting machine and a fiber waste collection device configured to collect fiber waste generated in the textile machine.

DESCRIPTION OF THE BACKGROUND ART

[0002] In a textile machine such as a false-twisting machine or spinning machine, fiber continues to be supplied even when threading the fiber on the textile machine, or even when replacing a package having the fiber wound on a winder arranged in the textile machine. In textile machines, therefore, it has been customary to suction to collect fiber waste during the yarn-threading or package-replacing operation.

[0003] Patent Document 1, e.g., discloses a suction device for continuously running multi-threads including a suctioning pipe arranged with a plurality of suctioning ports, a fiber waste collection container connected to an end of the suctioning pipe, and a negative pressure pump or suction blower connected to the fiber waste collection container. In the suction device disclosed in Patent Document 1, the pressure within the suctioning pipe becomes negative due to the operation of the negative pressure pump or suction blower, and the fiber waste suctioned into the suctioning pipe from the plurality of suctioning ports is suctioned through the suctioning pipe to be collected in the fiber waste collection container.

[0004] (Prior Art Documents)

(Patent Documents)

[0005] Patent Document 1: Japanese Patent Application Publication No. H06-40661

(Problems to be Solved)

[0006] In the suction device disclosed in Patent Document 1, the fiber waste along with air is suctioned through the suctioning pipe to be collected as a result of causing the negative pressure pump or suction blower to operate, where the pump or blower is connected via the fiber waste collection container to a downstream end side in a suction direction of the suctioning pipe. Due to such a suction device, there is a probability that the air accompanied with the fiber waste would be discharged to an exterior of the suction device.

SUMMARY OF THE INVENTION

[0007] The present invention has been made in view of the above-described technical problems, and an objective thereof is to provide a false-twisting machine and fiber waste collection device configured to separate fiber waste from air appropriately thereby capable of suppressing the discharge of the fiber waste to an exterior thereof.

(Means for Solving Problems)

[0008] A first aspect of the present invention is a false-twisting machine comprising a fiber waste collection device configured to collect fiber waste,
the fiber waste collection device including:

a fiber waste transfer pipe arranged with a plurality of suction units for suctioning the fiber waste generated in the false-twisting machine such that the fiber waste suctioned from the plurality of suction units is transferred along with air through the fiber waste transfer pipe;
a fiber waste collection unit for collecting therein the fiber waste transferred through the fiber waste transfer pipe;
a cyclone separator arranged between the fiber waste transfer pipe and the fiber waste collection unit configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe so as to collect the separated fiber waste in the fiber waste collection unit; and
an air discharge unit connected to the cyclone separator for discharging the air obtained having after been separated from the fiber waste,
wherein the fiber waste transfer pipe includes a plurality of fiber waste transfer pipes, and
the cyclone separator includes a plurality of cyclone separators each arranged to each of the plurality of fiber waste

transfer pipes.

[0009] The above-described first aspect of the false-twisting machine includes a fiber waste collection device configured to collect the fiber waste generated in the false-twisting machine. The fiber waste suctioned from the plurality of suction units is transferred through each fiber waste transfer pipe to be collected in the fiber waste collection unit via each cyclone separator connected to each fiber waste transfer pipe. The plurality of cyclone separators separate the fiber waste from the air transferred through the plurality of fiber waste transfer pipes, respectively. The separated fiber waste is collected in the fiber waste collection unit, and the air separated from the fiber waste is discharged from the air discharge unit. In such a manner, according to the plurality of cyclone separators arranged between their respective fiber waste transfer pipes and the fiber waste collection unit, the fiber waste and air are appropriately separated so that the discharge of the fiber waste from an interior of the air discharge unit to an exterior thereof can be suppressed. Further, each cyclone separator is arranged for each fiber waste transfer pipe. In other words, the plurality of fiber waste transfer pipes and the plurality of cyclone separators are connected, respectively, in a one-to-one configuration. In such a manner, the plurality of fiber waste transfer pipes and the plurality of cyclone separators can be connected, respectively, without having any restrictions imposed by another fiber waste transfer pipe. As a result, the plurality of fiber waste transfer pipes and the plurality of cyclone separators can be connected, respectively, at appropriate positions where the fiber waste and air are satisfactorily separated. It is to be noted that the term "appropriate position" corresponds to, *e.g.,* a position where the plurality of fiber waste transfer pipes are below a lower end portion of the air discharge unit.

[0010] A second aspect of the present invention is a false-twisting machine comprising a fiber waste collection device configured to collect fiber waste, the fiber waste collection device including:

a fiber waste transfer pipe arranged with a plurality of suction units for suctioning the fiber waste generated in the false-twisting machine such that the fiber waste suctioned from the plurality of suction units is transferred along with air through the fiber waste transfer pipe;
a fiber waste collection unit for collecting therein the fiber waste transferred through the fiber waste transfer pipe;
a cyclone separator arranged between the fiber waste transfer pipe and the fiber waste collection unit configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe so as to collect the separated fiber waste in the fiber waste collection unit; and
an air discharge unit connected to the cyclone separator for discharging the air obtained after having been separated from the fiber waste,
wherein the fiber waste transfer pipe includes a plurality of fiber waste transfer pipes, and
the fiber waste collection unit is arranged in a number smaller than a number of the plurality of fiber waste transfer pipes.

[0011] The above-described second aspect of the false-twisting machine includes a fiber waste collection device configured to collect the fiber waste generated in the false-twisting machine. The fiber waste suctioned from the plurality of suction units is transferred through each fiber waste transfer pipe to be collected in the fiber waste collection unit via the cyclone separator connected to each fiber waste transfer pipe. The cyclone separator separates the fiber waste from the air transferred through the plurality of fiber waste transfer pipes. The separated fiber waste is collected in the fiber waste collection unit, and the air separated from the fiber waste is discharged from the air discharge unit. In such a manner, according to the cyclone separator arranged between the plurality of fiber waste transfer pipes and the fiber waste collection unit, the fiber waste and air are appropriately separated so that the discharge of the fiber waste from an interior of the air discharge unit to an exterior thereof can be suppressed. Further, the fiber waste collection unit whose number is smaller than the number of fiber waste transfer pipes can make the overall size of the fiber waste collection device smaller. Still further, the cyclone separator arranged to make the fiber waste into a ball to be discharged can suppress the capacity of the fiber waste within the fiber waste collection unit. The fiber waste and air are separated so that the air obtained after having been separated from the fiber waste is discharged from the air discharge unit, and therefore, a volume occupied with the air can be suppressed in comparison to a case of a conventional fiber waste collection device incapable of isolating air itself having a blower connected to a fiber waste transfer pipe. As a result, according to the fiber waste collection device, a larger amount of fiber waste can be accumulated in the fiber waste collection unit in comparison to a case of a conventional fiber waste collection device, and the number of fiber collection waste units can be kept small. Still further, when the number of fiber waste collection units is smaller, a frequency of such replacement can be reduced thereby capable of reducing the burden on a worker.

[0012] As a consequence, according to the fiber waste collection device, the fiber waste and air can be satisfactorily separated, and thereby the discharge of the fiber waste from the air discharge unit to an exterior thereof can be further suppressed.

[0013] A third aspect of the present invention is the false-twisting machine in the above-described first or second aspect, wherein the cyclone separator includes a fiber waste discharge unit for discharging the fiber waste to the fiber waste collection unit, and the air discharge unit is adjusted so as to discharge the air whose flow rate is larger than a flow rate of air discharged from the fiber waste discharge unit.

[0014] According to the above-described third aspect of the false-twisting machine, the fiber waste and air can be satisfactorily separated, and thereby the discharge of the fiber waste from the air discharge unit to an exterior thereof can be further suppressed.

[0015] A fourth aspect of the present invention is the false-twisting machine in any one of the above-described first to third aspects,
wherein the air discharge unit has a lower end portion arranged above the fiber waste transfer pipe.

[0016] According to the above-described fourth aspect of the false-twisting machine, it is possible to prevent the fiber waste from being entangled with the air discharge unit, and good separation between the fiber discharge waste and the air is not hindered. As a result, the fiber waste and air can be satisfactorily separated.

[0017] A fifth aspect of the present invention is the false-twisting machine in any one of the above-described first to fourth aspects,
wherein the air discharge unit is arranged so as not to be within an interior of the cyclone separator while an interior of the air discharge unit communicating with an interior of the cyclone separator.

[0018] According to the above-described fifth aspect of the false-twisting machine, the air discharge unit is arranged so as not to be within an interior of the cyclone separator while an interior of the air discharge unit communicating with an interior of the cyclone separator, and thereby the fiber waste and air can be satisfactorily separated without any entanglement of the fiber waste with the air discharge unit.

[0019] The false-twisting machine in the above-described first aspect may be obtained by consisting exclusively of the above-described first aspect or may be obtained by arbitrarily combining the above-described first aspect and any of the above-described third to fifth aspects to such an extent that consistency can be achieved. When combining the above-described first aspect and any of the above-described third to fifth aspects, a combination of a part or the entirety of the above-described first aspect and a part or the entirety of any of the above-described third to fifth aspects may be performed to such an extent that consistency can be achieved. In a similar manner, the false-twisting machine in the above-described second aspect may be obtained by consisting exclusively of the above-described second aspect or may be obtained by arbitrarily combining the above-described second aspect and any of the above-described third to fifth aspects to such an extent that consistency can be achieved. When combining the above-described second aspect and any of the above-described third to fifth aspects, a combination of a part or the entirety of the above-described second aspect and a part or the entirety of any of the above-described third to fifth aspects may be performed to such an extent that consistency can be achieved.

[0020] A sixth aspect of the present invention is a fiber waste collection device comprising:

a fiber waste transfer pipe arranged with a plurality of suction units for suctioning fiber waste such that the fiber waste suctioned from the plurality of suction units is transferred along with air through the fiber waste transfer pipe;
a fiber waste collection unit for collecting therein the fiber waste transferred through the fiber waste transfer pipe;
a cyclone separator arranged between the fiber waste transfer pipe and the fiber waste collection unit configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe so as to collect the separated fiber waste in the fiber waste collection unit; and
an air discharge unit connected to the cyclone separator for discharging the air obtained after having been separated from the fiber waste,
wherein the fiber waste includes a polyester fiber or a polyamide fiber, and the cyclone separator includes
a body portion in a tubular shape connected with the fiber waste transfer pipe such that a longitudinal direction of the fiber waste transfer pipe follows an inner peripheral wall of the body portion, the body portion configured to cause the fiber waste transferred through the fiber waste transfer pipe to travel downward along the inner peripheral wall due to a centrifugal force,
a fiber waste transfer portion connected to a lower portion of the body portion, and
a fiber waste discharge unit for discharging the fiber waste separated from the air to the fiber waste collection unit,
wherein the fiber waste transfer portion has an inclined portion whose diameter decreases from a point of connection with the body portion toward the fiber waste discharge unit, and
the inclined portion is formed in a tapered shape having an angle formed with respect to a vertical direction within a range of larger than or equal to 7° and smaller than or equal to 10°.

[0021] According to the above-described sixth aspect of the fiber waste collection device, the fiber waste suctioned from the plurality of suction units transferred through the fiber waste transfer pipe travels via the cyclone separator connected to the fiber waste transfer pipe to be collected in the fiber waste collection unit. The cyclone separator causes the fiber waste to travel downward toward the fiber waste transfer portion along the inner peripheral wall in a tubular shape due to a centrifugal force so that the fiber waste is separated from the air transferred through the fiber waste transfer pipe. The separated fiber waste is formed into a ball to be discharged from the fiber waste discharge unit, and the discharged fiber waste is collected in the fiber waste collection unit. In such a manner, the discharge of the fiber waste from the air discharge unit to an exterior thereof can be suppressed. Here, the density of the polyester fiber is 1.4 g/cm^3 and the density of the polyamide fiber is 1.12 g/cm^3. For fibers having a relatively low density, such as polyester fiber and polyamide fiber, it is difficult to separate the fiber waste from air. To address this, the cyclone separator is arranged between the fiber waste transfer pipe and the fiber waste collection unit and, in such a manner, the fiber waste and air can be satisfactorily separated even when the density of the fiber waste is relatively low and the discharge of the fiber waste from the air discharge unit to an exterior thereof can be suppressed. By forming the inclined portion in a tapered shape having an angle formed with a vertical direction of 7° to 10° (inclusive of upper and lower limits), in particular, it becomes possible to accurately separate the fiber waste and air, and prevent the fiber waste discharge unit from being clogged with the fiber waste. As a result, the fiber waste can be satisfactorily discharged from the fiber waste discharge unit.

[0022] A seventh aspect of the present invention is the fiber waste collection device in the above-described sixth aspect, wherein the air discharge unit is adjusted so as to discharge the air whose flow rate is larger than a flow rate of air discharged from the fiber waste discharge unit.

[0023] According to the above-described seventh aspect of the fiber waste collection device, the fiber waste and air can be satisfactorily separated, and thereby the discharge of the fiber waste from the air discharge unit to an exterior thereof can be further suppressed.

[0024] An eighth aspect of the present invention is a fiber waste collection device comprising:

a fiber waste transfer pipe arranged with a plurality of suction units for suctioning fiber waste such that the fiber waste suctioned from the plurality of suction units is transferred along with air through the fiber waste transfer pipe;
a fiber waste collection unit for collecting therein the fiber waste transferred through the fiber waste transfer pipe;
a cyclone separator arranged between the fiber waste transfer pipe and the fiber waste collection unit configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe so as to discharge the separated fiber waste to the fiber waste collection unit; and
an air discharge unit connected to the cyclone separator for discharging the air obtained after having been separated from the fiber waste,
wherein the air discharge unit is adjusted so as to discharge the air whose flow rate is larger than a flow rate of air discharged from the cyclone separator to the fiber waste collection unit.

[0025] According to the above-described eighth aspect of the fiber waste collection device, the fiber waste suctioned from the plurality of suction units is transferred through the fiber transfer pipe to be collected in the fiber waste collection unit via the cyclone separator connected to the fiber transfer pipe. The cyclone separator separates the fiber waste from air transferred through the fiber transfer pipe. The separated fiber waste is collected in the fiber waste collection unit, and the air separated from the fiber waste is discharged from the air discharge unit. In such a manner, according to the cyclone separator arranged between the fiber transfer pipe and the fiber waste collection unit, the fiber waste and air can be satisfactorily separated, and thereby the discharge of the fiber waste from the air discharge unit can be suppressed. In particular, the air discharge unit is adjusted so as to discharge the air whose flow rate is larger than a flow rate of air discharged from the fiber waste discharge unit. The fiber waste can therefore be satisfactorily separated from the air, and thereby the discharge of the fiber waste from the air discharge unit to an exterior thereof can be further suppressed.

[0026] A ninth aspect of the present invention is the fiber waste collection in any one of the above-described sixth to eighth aspects,
wherein the air discharge unit has a lower end portion arranged above the fiber waste transfer pipe.

[0027] According to the above-described ninth aspect of the fiber waste collection device, it is possible to prevent the fiber waste from being entangled with the air discharge unit, and good separation between the fiber waste and the air is not hindered. As a result, the fiber waste and air can be satisfactorily separated.

[0028] A tenth aspect of the present invention is the fiber waste collection device in any one of the above-described sixth to ninth aspects,
wherein the air discharge unit is arranged so as not to be within an interior of the cyclone separator while an interior of the air discharge unit communicating with an interior of the cyclone separator.

[0029] According to the above-described tenth aspect of the fiber waste collection device, since the air discharge unit is provided communicating with an interior of the cyclone separator while avoiding entry into the cyclone separator, the fiber waste and air can be satisfactorily separated without the fiber waste becoming tangled with the air discharge unit.

[0030] The false-twisting machine in the above-described sixth aspect may be obtained by consisting exclusively of the above-described sixth aspect or may be obtained by arbitrarily combining the above-described sixth aspect and any of the above-described seventh, ninth, and tenth aspects to such an extent that consistency can be achieved. When combining the above-described sixth aspect and any of the above-described seventh, ninth, and tenth aspects, a combination of a part or the entirety of the above-described sixth aspect and a part or the entirety of any of the above-described seventh, ninth, and tenth aspects may be performed to such an extent that consistency can be achieved. In a similar manner, the false-twisting machine in the above-described eighth aspect may be obtained by consisting exclusively of the above-described eighth aspect or may be obtained by arbitrarily combining the above-described eighth aspect and the above-described ninth or tenth aspect to such an extent that consistency can be achieved. When combining the above-described eighth aspect and the above-described ninth or tenth aspect, a combination of a part or the entirety of the above-described eighth aspect and a part or the entirety of the above-described ninth or tenth aspect may be performed to such an extent that consistency can be achieved.

(Advantageous Effects of the Invention)

[0031] According to the present invention, it is possible to provide a false-twisting machine and fiber waste collection device configured to separate fiber waste from air appropriately thereby capable of suppressing the discharge of the fiber waste to an exterior thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

FIG. 1 is a schematic view showing an example of a false-twisting machine as a textile machine arranged with a fiber waste collection device.
FIG. 2 is a schematic view showing an example of a fiber waste collection device according to an embodiment of the present invention.
FIG. 3 is a cross-sectional view illustrating a suction unit arranged in a fiber waste transfer pipe.
FIG. 4 is a perspective view illustrating a cyclone separator and an air discharge unit.
FIG. 5 is a plan view illustrating a cyclone separator and an air discharge unit.
FIG. 6 is a front view illustrating a cyclone separator.
FIG. 7 is a front view illustrating a cyclone separator.
FIG. 8 is a graph showing an example of test results indicative of a relationship among a taper angle, a flow rate of air in an air discharge unit, and a flow rate of air in a fiber waste discharge unit.
FIG. 9 is a schematic view showing a fiber waste collection device according to a first modified embodiment of the present invention.
FIG. 10 is a schematic view showing a fiber waste collection device according to a second modified embodiment of the present invention.
FIG. 11 is a plan view of a cyclone separator according to a third modified embodiment of the present invention.
FIG. 12 is a perspective view of a cyclone separator according to a fourth modified embodiment of the present invention.

DESCRIPTIONS OF EMBODIMENTS OF THE INVENTION

[0033] Hereinafter, embodiments of the present invention will be described with reference to the drawings. The present invention can be widely applied to various uses as a fiber waste collection device arranged in a textile machine such as a false-twisting machine so as to collect fiber waste generated in the textile machine.

[0034] FIG. 1 is a schematic view showing a false-twisting machine 101 as a textile machine arranged with a fiber waste collection device 1 (see FIG. 2). FIG. 2 is a schematic view showing an example of fiber waste collection device 1 according to an embodiment of the present invention. A fiber waste collection device 1 is arranged in a textile machine such as a false-twisting machine 101 or spinning machine. In an embodiment according to the present invention, the false-twisting machine 101 will be described as an example of textile machine arranged with the fiber waste collection device 1. In the following description, initially, the false-twisting machine 101 arranged with the fiber waste collection device 1 will be described, and subsequently, the fiber waste collection device 1 according to an embodiment of the present invention will be described. For the convenience of description, an up-and-down direction, a forward-and-backward direction, and a left-and-right direction in the false-twisting machine 101 and the fiber waste collection device 1 are defined as shown in FIGS. 1 and 2.

[FALSE-TWISTING MACHINE]

[0035] The false-twisting machine 101 is configured, as a textile machine, to false-twist thermoplastic synthetic fibers such as polyester and polyamide so as to impart crimps to the false-twisted fibers, thereby producing highly stretchable textured yarns. As shown in FIG. 1, in the false-twisting machine 101, a main machine base 102 is arranged so as to extend in an up-and-down direction. Further, the false-twisting machine 101 includes: a yarn feeding creel 104 arranged so as to face the main machine base 102 across a work space 103 and holding a plurality of yarn feeding packages 105; a false-twisting device 106 arranged above the main machine base 102 so as to false-twist a fiber Y as a yarn supplied from the yarn feeding creel 104; a winder 107 arranged on the main machine base 102 so as to wind the false-twisted fiber Y obtained in the false-twisting device 106; and the like. The winders 107 are arranged in four stages along an up-and-down direction. Still further, a plurality of winders 107 are arranged side by side along a forward-and-backward direction in each of the first to fourth stages. It is to be noted that a forward-and-backward direction in which the plurality of winders 107 are arranged in each of the four stages arranged in an up-and-down direction is a direction along a horizontal direction as well as a direction vertical to a direction (left-and-right direction) in which the yarn feeding creel 104 and the main machine base 102 are arranged.

[0036] A first feeding roller 108, a shifter guide 109, a first heating device 110, and a cooling device 111 are arranged in this order from an upstream side in a yarn traveling direction on a yarn path from the yarn feeding creel 104 to the false-twisting device 106. A second feeding roller 112, an interlace nozzle 113, a second heating device 114, a third feeding roller 115, and an oiling roller 116 are arranged in this order from an upstream side in a yarn traveling direction on a yarn path from the false-twisting device 106 to the winder 107.

[0037] The first feeding roller 108 is arranged above the work space 103. The first heating device 110 is arranged above the work space 103 and further above the first feeding roller 108. The cooling device 111 is arranged closer to the main machine base 102 than to the first heating device 110 above the work space 103. The first heating device 110 and the cooling device 111 are arranged above the work space 103 so as to extend obliquely upward while being separated from the main machine base 102. The shifter guide 109 is arranged between the first feeding roller 108 and the first heating device 110 in an up-and-down direction, and is used to pass a fiber Y through the first heating device 110 and the cooling device 111 when threading a yarn on the false twisting machine 101.

[0038] The second feeding roller 112 is arranged above the main machine base 102. The interlace nozzle 113 is arranged above the main machine base 102 and below the second feeding roller 112. The second heating device 114 is arranged on the main machine base 102 and is arranged on a back side of the winder 107 when viewed from the work space 103 so as to extend in an up-and-down direction from the first stage to the fourth stage of the four-stages of winders 107. The devices are laid out in such a manner, and a yarn path from the yarn feeding creel 104 to the winder 107 is formed so as to surround the work space 103.

[0039] In the false-twisting machine 101, a fiber Y as a yarn supplied from the yarn feeding creel 104 is carried through the above-described devices and wound on the winder 107 to form a package 117. Initially, the first to third feeding rollers (108, 112, 115) are rollers for feeding a fiber Y from an upstream side to a downstream side in a yarn traveling direction. Each yarn feed velocity is set such that the yarn feed velocity of the second feeding roller 112 is faster than that of the first feeding roller 108. The fibers Y are, therefore, drawn between the first feeding roller 108 and the second feeding roller 112. Further, each yarn feeding velocity is set such that the yarn feeding velocity of the third feeding roller 115 is slower than that of the second feeding roller 112. The fiber Y is, therefore, loosened between the second feeding roller 112 and the third feeding roller 115.

[0040] Subsequently, the fibers Y drawn between the first feeding roller 108 and the second feeding roller 112 are twisted by the false-twisting device 106 that is, *e.g.,* a friction disk-type twister so as to be carried. The twist formed by the false-twisting device 106 propagates to the first feeding roller 108, and the fibers Y drawn to be twisted are heated by the first heating device 110 and thereafter cooled by the cooling device 111, and thereby, the twist is fixed. After passing through the false-twisting device 106, the twisted and heat-set fibers Y are untwisted before reaching the second feeding roller 112.

[0041] The fibers Y drawn and false-twisted in such a manner are appropriately entangled in the interlace nozzle 113 so as have bundling properties, and thereafter, are subjected to relaxation heat treatment in the second heating device 114 and wound on a paper tube by the winder 107 via the oiling roller 116 so as to form the package 117. Then, the fully-wound package 117 is removed by a worker from the winder 107. A new paper tube is attached by a worker to the winder 107, and a winding operation on the paper tube is restarted. In such a manner, the package 117 is replaced. The fiber waste collection device 1 of an embodiment according to the present invention is arranged in the false-twisting machine 101 described above, and is used. The fiber waste collection device 1 of an embodiment according to the present invention will be described below.

[OUTLINE OF FIBER WASTE COLLECTION DEVICE]

[0042] The fiber waste collection device 1 mainly includes, e.g., a plurality of fiber waste transfer pipes 11 (11a to 11d), one fiber waste collection unit 13 arranged for the plurality of fiber waste transfer pipes 11 (11a to 11d), and a plurality of cyclone separators 30 arranged correspondingly to the plurality of fiber waste transfer pipes 11 (11a to 11d), respectively, as shown in FIG. 2. The plurality of cyclone separators 30 are arranged between the plurality of fiber waste transfer pipes 11 (11a to 11d) and the fiber waste collection unit 13. Each of the plurality of cyclone separators 30 separates fiber waste from air transferred through each fiber waste transfer pipe 11 so as to collect the separated fiber waste in the fiber waste collection unit 13. Details of each cyclone separator 30 will be described later. It is to be noted that the term "fiber waste" includes thread-like cotton, fiber waste composed of a collection of relatively short fiber waste, a relatively short fiber waste, and a relatively long lint. Further, the fiber waste collection unit 13 described above corresponds to a "fiber waste collection unit" according to the present invention.

[0043] The fiber waste collection device 1 is arranged in the false-twisting machine 101 described above. The plurality of fiber waste transfer pipes 11 of the fiber waste collection device 1 are arranged correspondingly to their respective stages of the winders 107 arranged vertically in four stages, e.g., in the false-twisting machine 101. For this reason, the fiber waste collection device 1 according to an embodiment of the present invention arranged with such four-stage winders 107 includes four fiber waste transfer pipes 11 (11a to 11d), respectively. Each of the four fiber waste transfer pipes 11 (11a to 11d) is arranged so as to extend along a forward-and-backward direction. Winders 107 are arranged in each of the first to fourth stages of winder 107 side by side in a forward-and-backward direction, and each of the four fiber waste transfer pipes 11 (11a to 11d) is also arranged so as to extend along a forward-and-backward direction. Each fiber waste transfer pipe 11 (11a to 11d) suctions fiber Y (see FIG. 1) from regions in proximity to their respective winders 107 arranged side by side in a forward-and-backward direction at each of stages arranged in an up-and-down direction, and transfers the fiber Y along with air. Each of the four fiber waste transfer pipes 11 (11a to 11d) is connected to the fiber waste collection unit 13 in common. Further, the air accompanied with the fiber Y transferred through each of the four fiber waste transfer pipes 11 (11a to 11d) is separated at each cyclone separator 30 into fiber waste as the fiber Y and clean air obtained after having been separated from the fiber waste. The fiber waste separated from the air is collected in the fiber waste collection unit 13. The clean air obtained after having been separated from the fiber waste is discharged from an air discharge unit 50 (see FIG. 4 to be described later) to an exterior thereof.

[0044] In the meantime, each cyclone separator 30 is arranged so that the air obtained after having been separated from the fiber waste is discharged from the air discharge unit 50 (see FIG. 4 to be described later) to an exterior thereof, and therefore, the number of the fiber waste collection units 13 can be made smaller than the number of the fiber waste transfer pipes 11 (11a to 11d), and an overall size of the fiber waste collection device 1 can be made smaller. In other words, by arranging each cyclone separator 30, the fiber waste can be made into a ball to be discharged and thereby the volume occupied with such a fiber waste within the fiber waste collection unit 13 can be suppressed. Further, by separating the fiber waste and air so as to discharge the air obtained after having been separated from the fiber waste from the air discharge unit 50, the volume occupied with the air can be suppressed in comparison to a case of a conventional fiber waste collection device incapable of isolating air itself, e.g., having a blower connected to a fiber waste transfer pipe (11 (11a to 11d)). As a result, according to the fiber waste collection device 1 of an embodiment according to the present invention, a larger amount of fiber waste can be accumulated in the fiber waste collection unit 13 in comparison to a case of a conventional fiber waste collection device and thereby, the number of fiber waste collection units 13 can be suppressed. Still further, when the number of fiber waste collection units 13 is smaller, a frequency of replacement can be reduced thereby capable of reducing burden on a worker. It is to be noted that, in an embodiment according to the present invention, one fiber waste collection unit 13 is arranged for all of the plurality of fiber waste transfer pipes 11 (11a to 11d); however, the number of fiber waste collection units 13 is not limited to this, and may be smaller than the number of fiber waste transfer pipes 11 (11a to 11d).

[0045] The fiber waste collection device 1 keeps thread when the thread is changed at the winder 107 of the false-twisting machine 101 without cutting the thread so as to collect the thread as fiber waste. In other words, as shown in FIG. 1, when the fiber Y is threaded on the false-twisting machine 101 or when the package 117 on the winder 107 of the false-twisting machine 101 is replaced, the fiber waste collection device 1 is used in order that: the fiber Y is continuously supplied from the thread-feeding creel 104 to a region in proximity to the winder 107 via each device (110, 111, 106, 114) so as to be collected as fiber waste from each suction unit. In such a manner, when the package 117 is replaced at the winder 107 of the false-twisting machine 101, the fiber Y supplied continuously in proximity to the winder 107 can be collected, and therefore, the false-twisting machine 101 can continuously operate without any need of cutting the thread. Further detailed configuration of the fiber waste collection device 1 will be described below.

[FIBER WASTE TRANSFER PIPE]

[0046] As shown in FIG. 2, the plurality of suction units 15 configured to suction the fiber Y (see FIG. 1) are arranged in proximity to each winder 107, and each of the plurality of fiber waste transfer pipes 11 (11a to 11d) serves as a pipe through which the fiber Y suctioned from the plurality of suction units 15 is transferred. It is to be noted that each suction unit 15 configured to suction the fiber Y will be described later. Each fiber waste transfer pipe 11 is formed, e.g., in a hollow tubular shape. A plurality of fiber waste transfer pipes 11 (11a to 11d) are arranged and, in an embodiment according to the present invention, four fiber waste transfer pipes 11 are arranged as described above.

[0047] The four fiber waste transfer pipes 11 (11a to 11d) include a first fiber waste transfer pipe 11a corresponding to a first stage of the winder 107 as the lowest stage, a second fiber waste transfer pipe 11b corresponding to a second stage of the winder 107 above the first stage, a third fiber waste transfer pipe 11c corresponding to a third stage of the winder 107 above the second stage, and a fourth fiber waste transfer pipe 11d corresponding to a fourth stage of the winder 107 above the third stage. Each of the four fiber waste transfer pipes 11 (11a to 11d) is arranged in the false-twisting machine 101 such that a longitudinal direction of each fiber waste transfer pipe 11 (11a to 11d) extends along a forward-and-backward direction. Further, each of the first to fourth fiber waste transfer pipes 11 (11a to 11d) extends along a forward-and-backward direction at each of the first to fourth stage of winder 107. In an embodiment according to the present invention, the cyclone separator 30 includes: a first cyclone separator 30a arranged between the first fiber waste transfer pipe 11a and the fiber waste collection unit 13; a second cyclone separator 30b arranged between the second fiber waste transfer pipe 11b and the fiber waste collection unit 13; a third cyclone separator 30c arranged between the third fiber waste transfer pipe 11c and the fiber waste collection unit 13; and a fourth cyclone separator 30d arranged between the fourth fiber waste transfer pipe 11d and the fiber waste collection unit 13.

[0048] Each of the four fiber waste transfer pipes 11 (11a to 11d) has a longitudinal portion extending along a forward-and-backward direction at one end side (backward-side portion shown in FIG. 2) as closed and a portion at the other end side (forward-side portion shown in FIG.2) connected to each cyclone separator 30.

[SUCTION UNITS]

[0049] As shown in FIG. 2, a set of plurality of suction units 15 is arranged as a mechanism to suction fibers Y (see FIG. 1). A plurality of suction units 15 are arranged in each of the plurality of fiber waste transfer pipes 11 (11a to 11d). Each of the plurality of suction units 15 arranged in each fiber waste transfer pipe 11 includes a suction pipe 16 and an opening/closing mechanism 17 (see FIG. 3 to be described later), and the plurality of suction units 15 are arranged side by side in a longitudinal direction of each fiber waste transfer pipe 11 (11a to 11d). The plurality of suction units 15 arranged side by side in each of the fiber waste transfer pipes 11 (11a to 11d) are arranged correspondingly to a plurality of winders 107 in each fiber waste transfer pipe 11 (11a to 11d). More specifically, a plurality of sets of the suction units 15 are arranged in the plurality of fiber waste transfer pipes 11 (11a to 11d) correspondingly to a plurality of stages of the winders 107, e.g., four stages of winders 107 (see FIG. 1) arranged vertically in the false-twisting machine 101 (see FIG. 1), where the plurality of winders 107 in each stage are arranged side by side in a forward-and-backward direction correspondingly to the plurality of suction units 15.

[0050] In a similar manner, the plurality of sets of suction units 15 arranged vertically in the first to fourth fiber waste transfer pipes 11 (11a to 11d), respectively. Further, in a similar manner, the plurality of suction units 15 are arranged side by side in each fiber waste transfer pipe 11 (11a to 11d).

[0051] Each suction pipe 16 is arranged as a tubular member for suctioning the fiber Y (see FIG. 1) smaller in diameter than each of the plurality of fiber waste transfer pipes 11 (11a-11d) so as to extend with a bend in the middle. Each suction pipe 16 has one end side connected to each of the plurality of fiber waste transfer pipes 11 (11a-11d) and the other end side arranged with a suction port (not shown) formed in proximity to the winder 107 (see FIG. 1) through which the fiber Y is suctioned. The fiber Y suctioned through the suction port flows into each fiber waste transfer pipe 11.

[0052] FIG. 3 is a cross-sectional view of each suction unit arranged in a fiber waste transfer pipe. It is to be noted that, in FIG. 3, the opening/closing mechanism 19 is in a state of being pushed upward so that a suction port 16a is in an opened state. As shown in FIG. 3, each suction pipe 16 is connected to each of the plurality of fiber waste transfer pipes 11 (11a to 11d) in a tilted state. Each of the plurality of suction pipes 16 is connected to each of the plurality of fiber waste transfer pipes 11 (11a to 11d) at an acute angle with respect to a direction from upstream (backward side shown in FIG. 3) to downstream (forward side shown in FIG. 3) of air flow through each fiber waste transfer pipe 11. In other words, each of the plurality of suction pipes 16 is connected to each fiber waste transfer pipe 11 (11a to 11d) at an acute angle with respect to a direction from one end side (backward side shown in FIG. 3) to the other end side (forward side shown in FIG. 3) connected to the fiber waste collection unit 13. As a result, when the fiber Y (see FIG.1) suctioned from each suction port (not shown) flows into each fiber waste transfer pipe 11, such a fiber Y flows in a direction from upstream to downstream of air flow in each fiber waste transfer pipe 11. After flowing into each fiber waste transfer pipe 11, the fiber Y is transferred downstream by air flowing through the fiber waste transfer pipe 11.

[0053] Each of the plurality of suction pipes 16 includes a compressed air injection nozzle hole 16d and a guide path 16e. The compressed air injection nozzle hole 16d is arranged as a nozzle hole for injecting compressed air into each suction pipe 16 between one end side arranged with an outlet opening 16b and the other end side arranged with the suction opening 16a. The compressed air injection nozzle hole 16d is formed so as to inject compressed air toward the one end side arranged with the outlet opening 16b within each suction pipe 16. In an embodiment according to the present invention, two compressed air injection nozzle holes 16d are arranged. Each of such two compressed air injection nozzle holes 16d extends from a side arranged with the suction opening 16a toward a side arranged with the outlet opening 16b as well as from an outer periphery of the suction pipe 16 toward an inner periphery of the suction pipe 16, thereby capable of communicating with a suction flow path 16c. In such a manner, each of the two compressed air injection nozzle holes 16d is configured to inject compressed air toward one end side arranged with the outlet opening 16b within the suction pipe 16. It is to be noted that the number of compressed air injection nozzle holes 16d is not limited to two.

[0054] The guide path 16e of each suction pipe 16 is arranged within the suction pipe 16 as a flow path for compressed air extending annularly along a circumferential direction of the suction pipe 16. The guide path 16e communicating with the compressed air injection nozzle hole 16d and a cylinder chamber 20 to be described below. A compressed air supplied to the cylinder chamber 20 flows into the guide path 16e via the compressed air injection nozzle hole 16d to be injected into the suction flow path 16c.

[0055] The cylinder chamber 20 is defined as a cylindrical space of a body portion 18. The cylinder chamber 20 communicating with the guide path 16e of each suction pipe 16 via a communication path 20a arranged within the body portion 18. Accordingly, the compressed air supplied to the cylinder chamber 20 flows into the guide path 16e to further flow into the compressed air injection nozzle hole 16d. Further, the cylinder chamber 20 is connected so as to communicate with a compressed air supply pipe 23 for supplying compressed air thereby to be injected from the compressed air injection nozzle hole 16d of each suction pipe 16. The compressed air supply pipe 23 is connected to a compressed air supply source (not shown) for supplying compressed air. The compressed air supply pipe 23 is arranged with a solenoid valve 24 for controlling the supply of compressed air to the cylinder chamber 20 by opening and closing the valve so that it can be switched between a connected state and a shut-off state. When the solenoid valve 24 is opened, the compressed air supply pipe 23 enters a communicative state so that the compressed air is supplied from the compressed air supply pipe 23 toward the cylinder chamber 20. When the solenoid valve 24 is closed, the supply of the compressed air from the compressed air supply pipe 23 toward the cylinder chamber 20 is interrupted.

[0056] In each suction unit 15, in a state where the solenoid valve 24 is closed and the compressed air is not supplied to the cylinder chamber 20 due to shutting-off of the compressed air supply pipe 23, the opening/closing member 19 is caused to rotate around a rotating shaft 29 so as to close the suction pipe 16a with the aid of a biasing force applied by a spring member 22 arranged in a spring chamber 25. In such a state, an operation of suctioning the fiber Y (see FIG. 1) is not performed by the suction unit 15. On the other hand, in a state where the solenoid valve 24 is opened so as to communicate with the compressed air supply pipe 23 and thereby the compressed air is supplied to the cylinder chamber 20, a piston 21 is caused to move upward so as to push the opening/closing member 19 upward, resulting in opening the suction port 16a. Further, in a state where the compressed air is supplied to the cylinder chamber 20, the compressed air flows into the compressed air injection nozzle hole 16d and the compressed air is injected from the compressed air injection nozzle hole 16d to the suction flow path 16c of the suction pipe 16. The compressed air injected to the suction flow path 16c is injected toward the outlet opening 16b. As a result, the compressed air injected into the suction pipe 16 from the compressed air injection nozzle hole 16d generates air flow within the suction pipe 16 to transfer the fiber Y toward the fiber waste transfer pipe 11, and further generates air flow within the fiber waste transfer pipe 11 to transfer the fiber Y toward the cyclone separator 30 (forward side shown in FIG. 3). In such a manner, the fiber Y suctioned from the suction port 16a can be transferred to the fiber waste transfer pipe 11.

[0057] It is to be noted that another configuration may be adopted if the fiber Y (see FIG. 1) can be suctioned from each suction port so that the suctioned fiber Y can be transferred through each of the plurality of fiber waste transfer pipes 11 (11a to 11d). The compressed air, e.g., may be injected into each suction pipe 16 as described above and the pressure within each fiber waste transfer pipe 11 may be reduced by suctioning, e.g., with a blower.

[0058] The air velocity in each of the plurality of fiber waste transfer pipes 11 (11a to 11d) is preferably 1000 m/min or higher. If the air velocity in the fiber waste transfer pipe 11 is less than 1000 m/min, e.g., therefore, a connection unit for supplying the compressed air can be arranged at one end side of fiber waste transfer pipe 11 (11a to 11d) (*e.g.,* at a backward end), and the compressed air supplied from a compressed air supply source (not shown) can be supplied to the fiber waste transfer pipe 11 (11a to 11d) from one end side of the fiber waste transfer pipe 11 (11a to 11d). A conventionally arranged blower may also be arranged in proximity to the cyclone separator 30 to suction an interior of the fiber waste transfer pipe 11 (11a to 11d) to make up the shortfall required to fulfill, *e.g.*, an air velocity of 1000 m/min.

[CYCLONE SEPARATOR]

[0059] FIG. 4 is a perspective view illustrating a cyclone separator 30 and an air discharge unit 50. FIG. 5 is a plan view illustrating a cyclone separator 30 and an air discharge unit 50. FIG. 6 is a front view illustrating a cyclone separator 30. In FIGS. 4 to 6, a connection portion with the fiber waste transfer pipe 11 is also shown. It is to be noted that, in an embodiment according to the present invention, as described above, a first cyclone separator 30a to a fourth cyclone separator 30d are arranged such that the first cyclone separator 30a to the fourth cyclone separator 30d are the same in configuration as each other.

[0060] As shown in FIG. 4, the cyclone separator 30 includes: a body portion 32 in a tubular shape; a tapered portion 42 arranged below the body portion 32; and a fiber waste discharge unit 46 for discharging fiber waste separated from air to the fiber waste collection unit 13 (see FIG. 2). The body portion 32 has a tubular portion 34 forming a side wall and a top face portion 36 forming a top end face of the tubular portion 34. The top face portion 34 is perforated with an opening 38 concentric with the tubular portion 34 smaller in diameter than the tubular portion 34. It is to be noted that the cyclone separator 30 does not separate completely the air and the fiber waste, and that air is also present in the fiber waste obtained after having been separated from the air. For this reason, not only fiber waste but also unseparated air is discharged from the fiber waste discharge unit 46.

[0061] The tapered portion 42 has a circular top end portion the same in diameter as the tubular portion 34 and a circular bottom end portion smaller in diameter than the circular top end portion. The tapered portion 42 has the top end portion and bottom end portion both opened, and has an inclined portion 44 linearly narrowing from the top end portion to the bottom end portion in a plan view. The inclined portion 44 preferably has an angle θ (hereinafter, referred to as "taper angle θ") as an acute angle between a vertical direction and a direction of the inclined portion 44 within a range from 7° to 10° (inclusive of upper and lower limits). The tapered portion 42 has the top end portion connected to a bottom end portion of the tubular portion 34. Further, there is no partitioning member between the tapered portion 42 and the body portion 32, and an interior of the tapered portion 42 communicates with an interior of the body portion 32. The "tapered portion 42" corresponds to a "fiber waste transfer portion" according to the present invention.

[0062] The fiber waste discharge unit 46 is in a tubular shape and has both ends opened. The fiber waste discharge unit 46 and the tapered portion 42 are the same in inner diameter as each other. The fiber waste discharge unit 46 has a top end portion connected to a bottom end portion of the tapered portion 42 such that the connected top and bottom end portions are concentric with each other. Further, the fiber waste discharge unit 46 has a bottom end portion connected to the fiber waste collection unit 13 (see FIG. 2). There is no partitioning member between the fiber waste discharge unit 46 and the tapered portion 42, and an interior of the fiber waste discharge unit 46 communicates with an interior of the body portion 32.

[0063] The air discharge unit 50 for discharging the air obtained after having been separated from the fiber waste to an exterior thereof is arranged above the cyclone separator 30. The air discharge unit 50 is in a tubular member, and has both ends opened. The air discharge unit 50 and the opening 38 are the same in inner diameter as each other. The air discharge unit 50 has a bottom end portion connected to the opening 38 such that the bottom end portion and the opening 38 are concentric with each other. More specifically, the air discharge unit 50 is connected to the body portion 32 such that the cylindrical portion of the air discharge unit 50 is not within an interior of the body portion 32 of the cyclone separator 30, and a bottom edge of the cylindrical portion of the air discharge unit 50 and a bottom face of the top face portion 36 of the cyclone separator 30 (more specifically, the body portion 32) are flush with each other.

[0064] It is to be noted that, as shown in FIG. 6, a lower end portion 50a of a tubular portion of the air discharge unit 50 is preferably above a top end portion 11U of the fiber waste transfer pipe 11. Based upon the findings of the present inventors, when the lower end portion 50a of the tubular portion of the air discharge unit 50 is below the top end portion 11U of the fiber waste transfer pipe 11, the fiber waste is entangled with a cylindrical portion of the air discharge unit 50, which results in preventing good separation of the fiber waste from the air. To address this, the lower end portion 50a of the tubular portion of the air discharge unit 50 is adjusted so as to be higher than at least the top end portion 11U of the fiber waste transfer pipe 11, and as a result, the fiber waste can be prevented from being entangled with the cylindrical portion of the air discharge unit 50 and thereby, the fiber waste and air can be satisfactorily separated. In an embodiment according to the present invention, as shown in FIG. 4, a lower end portion of the cylindrical portion of the air discharge unit 50 and a lower face of the top face portion 36 (see FIG. 4) of the body portion 32 are flush with each other, and as a result, the lower end portion of the cylindrical portion of the air discharge unit 50 is higher than the top end portion of the fiber waste transfer pipe 11, and thereby, the fiber waste and air can be separated satisfactorily.

[0065] In the meantime, when the plurality of fiber waste transfer pipes 11 (11a to 11d) are connected to one cyclone separator 30, there is a probability that the connection positions between the plurality of fiber waste transfer pipes 11 (11a to 11d) and the cyclone separator 30 would be restricted. A connection position between, e.g., one fiber waste transfer pipe 11a out of the plurality of fiber waste transfer pipes 11 (11a to 11d) and the cyclone separator 30 is restricted by the other fiber waste transfer pipes 11b to 11d. In such a case, it would be difficult to connect one fiber waste transfer pipe 11a to the cyclone separator 30 such that the one fiber waste transfer pipe 11a is below the lower end portion of the cylindrical portion of the air discharge unit 50. To address this, connecting each of the plurality of fiber waste transfer pipes 11 (11a to 11d) to the cyclone separator 30 on a one-to-one basis makes it possible to connect the fiber waste transfer pipe 11 (11a to 11d) and the cyclone separator 30 at an appropriate position where the fiber waste and air are satisfactorily separated, i.e., a position where the fiber waste transfer pipe 11 (11a to 11d) is lower than the lower end portion of the cylindrical portion of the air discharge unit 50.

[0066] There is no partitioning member between the air discharge unit 50 and the cyclone separator 30 (more specifically, the body portion 32), and an interior of the air discharge unit 50 communicates with an interior of the cyclone separator 30. Further, based upon the findings of the present inventors, when an inner diameter of the fiber waste discharge unit 46 (*i.e.,* an inner diameter of the lower end portion of the tapered portion 42) is larger than an inner diameter of the air discharge unit 50 (*i.e.,* an inner diameter of the opening 38), there is a probability that the fiber waste and air would be insufficiently separated and therefore some fiber waste would be discharged from the air discharge unit 50. For this reason, an inner diameter of the fiber waste discharge unit 46 (*i.e.,* an inner diameter of the lower end portion of the tapered portion 42) is preferably smaller than an inner diameter of the air discharge unit 50 (*i.e.,* an inner diameter of the opening 38).

[0067] It is to be noted that, in an embodiment according to the present invention, both the air discharge unit 50 and the fiber waste discharge unit 46 are in a tubular shape; however, the shape is not limited to this, and a prismatic shape may be adopted. In such a case, an open area of a portion communicating with an interior of the body portion 32 (*i.e.,* a portion of being connected with the top face portion 36) in a horizontal direction is preferably larger than an open area of the fiber waste discharge unit 46 in a horizontal direction.

[0068] As shown in FIG. 5, the fiber waste transfer pipe 11 is connected to the body portion 32 at an upper portion of the body portion 32 such that a longitudinal direction of the fiber waste transfer pipe 11 follows an inner peripheral wall 35 of the body portion 32 of the cyclone separator 30. In other words, in a plan view, the fiber waste transfer pipe 11 is connected to the body portion 32 so as to be tangent to the tubular portion 34 of the body portion 32 of the cyclone separator 30. More specifically, the fiber waste transfer pipe 11 is connected to the body portion 32 of the cyclone separator 30 such that a direction of travel of air containing fibers as the fiber waste transferred through the fiber waste transfer pipe 11 is along the inner peripheral wall 35 of the tubular portion 34. When the fiber waste transfer pipe 11 is connected to the cyclone separator 30 in such a way, as shown in FIG. 4, the air containing the fiber waste transferred through the fiber waste transfer pipe 11 travels in a circumferential direction along the inner peripheral wall 35 of the tubular portion 34. The fiber waste contained in the air is, therefore, transferred downward while turning in a circumferential direction along the inner peripheral wall 35 of the tubular portion 34 due to a centrifugal force, i.e., a centrifugation action. The fiber waste having been caused to move downward while turning along the inner peripheral wall 35 of the tubular portion 34 is further transferred to the fiber waste discharge unit 46 along an inner peripheral wall 45 of the inclined portion 44. After having been transferred to the fiber waste discharge unit 46, the fiber waste is transferred from the fiber waste discharge unit 46 toward the fiber waste collection unit 13 (see FIG. 2). In such a manner, the fiber waste having been transferred through the fiber waste transfer pipe 11 is separated from the air containing fiber waste, and the separated fiber waste is collected in the fiber waste collection unit 13. Meanwhile, the air separated from the fiber waste is discharged from the air discharge unit 50 to an exterior thereof.

[0069] It is to be noted that, when each of the plurality of fiber waste transfer pipes 11 (11a to 11d) and the cyclone separator 30 are connected on a one-to-one basis, such fiber waste transfer pipes 11 (11a to 11d) and the cyclone separator 30 may be connected at their respective appropriate positions so that the inner peripheral wall 35 of the tubular portion 34 can be secured to ensure that the fiber waste is transferred to the tapered portion 42.

[EFFECTS]

[0070] According to the fiber collection device 1 as an embodiment of the present invention, the fiber Y suctioned from the plurality of suction units 15 is transferred through each fiber waste transfer pipe 11 to be collected as the fiber waste in the fiber waste collection unit 13 via the cyclone separator 30 connected to each fiber waste transfer pipe 11. The cyclone separator 30 separates the fiber waste from the air transferred through the plurality of fiber waste transfer pipes 11. The separated fiber waste is collected in the fiber waste collection unit 13, and the air separated from the fiber waste is discharged from the air discharge unit 50. In such a manner, according to the cyclone separator 30 arranged between the plurality of fiber waste transfer pipes 11 and the fiber waste collection unit 13, the fiber waste and air are appropriately separated so that the discharge of the fiber waste from an interior of the air discharge unit 50 to an exterior thereof can be suppressed.

[0071] Further, according to the fiber waste collection device 1 as an embodiment of the present invention, the fiber waste transfer pipe 11 is connected to the body portion 32 such that a longitudinal direction of thereof follows the inner peripheral wall 35 of the tubular portion 34. As a result, the air is caused to move in a circumferential direction along the inner peripheral wall 35 of the tubular portion 34 and the fiber waste transferred through the fiber waste transfer pipe 11 is caused to move downward along the inner peripheral wall 35 of the tubular portion 34 and the inner peripheral wall 45 of the inclined portion 44 due to a centrifugal force, i.e., a centrifugation action and is separated from the air. The fiber waste separated from the air is allowed to pass through the fiber waste discharge unit 46 so as to be collected in the fiber waste collection unit 13. The clean air obtained after having been separated from the fiber waste is discharged from the air discharge unit 50. In the meantime, the air discharge unit 50 is connected to the body portion 32 such that the air discharge unit 50 never enters an interior of the body portion 32 as well as the bottom end portion of the air discharge unit 50 and the top face portion 36 of the body portion 32 are flush with each other. As a result, the fiber waste is not entangled with the air discharge unit 50 and the fiber waste and air can be satisfactorily separated.

[0072] Still further, according to the fiber waste collection device 1 as an embodiment of the present invention, the tapered portion 42 includes the inclined portion 44 decreasing in diameter from a point of connection with the body portion 32 toward the fiber waste discharge unit 46. The fiber waste and air can be separated in the inclined portion 44, and the discharge of the fiber waste from the air discharge unit 50 to an exterior thereof can further suppressed. It is to be noted that the above-described inclined portion 44 in in a tapered shape having an angle with respect to a vertical direction within a range from 7° to 10° (inclusive of upper and lower limits), and therefore, the fiber waste and air can be accurately separated and the fiber waste discharge unit 46 can be prevented from being clogged with the fiber waste. As a result, the fiber waste can be satisfactorily discharged from the fiber waste discharge unit 46. More particularly, if the fiber waste is relatively dense, it is relatively easy to separate the fiber waste from air. As described above, the false-twisting machine 101 crimps thermoplastic synthetic fibers, such as polyester and polyamide, by applying false twisting. The density of the polyester fiber is 1.4 g/cm^3, the density of the polyamide fiber is 1.12 g/cm^3, relatively low densities for fibers, and thus it is difficult to separate polyester or polyamide from air. In this regard, according to the fiber waste collection device 1 as an embodiment of the present invention, even when the density of the fiber waste is small, as in the case of polyester or polyamide, the fiber waste and air can be satisfactorily separated. Further, the separated fiber waste can be discharged from the fiber waste discharge unit 46, and the discharged fiber waste is collected in the fiber waste collection device 1, and thereby, the discharge of the fiber waste from the air discharge unit to an exterior thereof can be suppressed.

[0073] Still further, according to the fiber waste collection device 1 as an embodiment of the present invention, an inner diameter of the fiber waste discharge unit 46 (*i.e.,* the lower end portion of the tapered portion 42) is smaller than an inner diameter of the air discharge unit 50 (*i.e.,* the inner diameter of the opening 38). As a result, the fiber waste and air can be satisfactorily separated and discharge of the fiber waste from the air discharge unit to an exterior thereof can be further suppressed.

[EXPERIMENTAL EXAMPLES]

[0074] An embodiment according to the present invention was supported by the following experimental examples. The results of such experimental examples will be described. FIG. 7 is a front view illustrating a cyclone separator 30. FIG. 8 is a graph showing an example of test results indicative of a relationship among a taper angle θ, a flow rate of air in an air discharge unit 50, and a flow rate of air in a fiber waste discharge unit 46. The fiber used in EXPERIMENTAL EXAMPLES 1, 2, and 3 below is 75 denier false-twisted yarn.

[0075] It is to be noted that, in FIGS. 7 and 8, a vertical direction is defined as a Y-direction, and in particular, an upper direction is defined as a Y-direction at a positive side and a lower direction is defined as a Y-direction at a negative side. The flow rate shown in FIG. 8 represents the flow rate of a vector component in a Y-direction. When the value of the flow rate is positive, the flow of air is in a Y-direction at a positive side and when the value of the flow rate is negative, the flow of air is in a Y-direction at a negative side.

[0076] Further, as shown in FIG. 7, the dimensions of each part of the cyclone separator 30 are as follows: Y-direction length a of the entire cyclone separator 30; Y-direction length b of the body portion 32; inner diameter c of the body portion 32; Y-direction length d of the air discharge unit 50; inner diameter e of the air discharge unit 50; Y-direction length f of the inclined portion 44; Y-direction length g of the fiber waste discharge unit 46; inner diameter h of the fiber waste discharge unit 46; and taper angle θ. In EXPERIMENTAL EXAMPLE 2 described below, an inner diameter of an inlet of the fiber waste transfer pipe 11, as a point of connecting with the cyclone separator 30, is expressed as i.

[EXPERIMENTAL EXAMPLE 1]

[0077] In EXPERIMENTAL EXAMPLE 1, the dimensions of each part of the cyclone separator 3 were a = 280 mm, b = 80 mm, c (inner diameter) = 80 mm, d = 50 mm, e (inner diameter) = 48 mm, g = 10 mm, h (inner diameter) = 31 mm, and the taper angle θ was changed, and the favorability of the fiber waste discharged from the fiber waste discharge unit 46 (hereinafter, referred to as "favorability of fiber waste discharge") was evaluated. Evaluation was performed at taper angles θ of 10°, 15°, 30°, and 40°. It is to be noted that the Y-direction length f of the inclined portion 44 is a dimension set according to the taper angle θ.

[0078] The evaluation results obtained in EXPERIMENT 1 are shown in TABLE 1. TABLE 1 is an example of experiment results showing the relationship between the taper angle θ and the favorability of fiber waste discharge. To ensure favorable discharge from the fiber waste discharge unit 46, it is important that the fiber waste be made into a ball. The fiber waste having formed a ball and been satisfactorily discharged from the fiber waste discharge unit 46 was judged as "Good", the fiber waste having not formed a ball and not been discharged from the fiber waste discharge unit 46 was judged as "Bad", and the fiber waste having formed a ball but clogged the fiber waste discharge unit 46 once out of five times was judged as "Middle".

[TABLE 1]

Taper angle θ	10°	15°	30°	45°
Favorability of fiber waste discharge	Middle	Bad	Bad	Bad

[0079] As shown in TABLE 1, when the taper angle θ exceeds 10°, the favorability of fiber waste discharge had a "Bad" determination. When the taper angle θ was 10°, in EXPERIMENT 1, once of five times, the fiber waste clogged in the fiber waste discharge unit 46, resulting in a "Middle" judgment, but four out of five times, the fiber waste formed a ball and was discharged from the fiber waste discharge unit 46, resulting in a judgment close to a "Middle" judgment. Although not shown in TABLE 1, when the taper angle θ was less than 10°, the favorability of fiber waste discharge in all cases resulted in a "Good" judgment.

[0080] The above evaluation results indicate that a taper angle θ of 10° or less is preferable from the perspective of good fiber waste discharged from the fiber waste discharge unit 46.

[EXPERIMENTAL EXAMPLE 2]

[0081] In EXPERIMENTAL EXAMPLE 2, the dimensions of each part of the cyclone separator 3 were a = 300.1 mm, b = 90 mm, c = 90 mm, d = 30 mm, e = 48 mm, f = 170.1 mm, g = 10 mm, i = 21 mm, only the taper angle θ was changed, the changes in the flow rate of air in a Y-direction in the air discharge unit 50 and the flow rate of air in a Y-direction in the fiber waste discharge unit 46 were evaluated. Evaluation was performed at taper angles θ of 10°, 9°, 7°, and 5°. It is to be noted that the inner diameter h of the fiber waste discharge unit 46 is a dimension set according to the taper angle θ. Further, the air velocity within an interior of the fiber waste transfer pipe 11 is assumed to be 1000 m/min, and the mass flow rate of air at the inlet of fiber waste transfer pipe 11 is 0.014896 kg/s.

[0082] The evaluation results obtained in EXPERIMENT 2 indicate, assuming that the inner diameter e of the air discharge unit 50 and the inner diameter h of the fiber waste discharge unit 46 are constant sizes, the flow rate of air discharged from the air discharge unit 50 (the flow rate in a Y-direction at a positive side) decreases when the flow rate of air discharged from the fiber waste discharge unit 46 (the flow rate in a Y-direction at a negative side) increased, as shown in FIG. 8. Further, the flow rate of air discharged from the air discharge unit 50 decreases as the taper angle θ decreases. On the other hand, the flow rate of air discharged from the fiber waste discharge unit 46 stayed constant without decreasing at a taper angle θ of 7° or higher. Incidentally, when the inner diameter e of the air discharge unit 50 and the inner diameter h of the fiber waste discharge unit 46 were constant and the taper angle θ was small, the Y-direction length f of the inclined portion 44 increased as a result. When the Y-direction length f of the inclined portion 44 increases, the Y-direction length a of the overall cyclone separator 30 increases and pressure loss is thought to increase. Accordingly, when the taper angle θ is less than 7°, the ratio of the flow rate of air discharged from the fiber waste discharge unit 46 to the flow rate of air discharged from the air discharge unit 50 is thought to increase. According to the inventor's findings, if the flow rate of air discharged from the fiber waste discharge unit 46 is larger than the flow rate of air discharged from the air discharge unit 50, the fiber waste and air will not be satisfactorily separated. Therefore, the lower limit of the taper angle θ is preferably 7° or more.

[0083] The results of EXPERIMENTS 1 and 2 above indicate that the taper angle θ is preferably in the range of 7° to 10° (inclusive of upper and lower limits).

[EXPERIMENTAL EXAMPLE 3]

[0084] In EXPERIMENTAL EXAMPLE 3, a relationship between the inner diameter h of the fiber waste discharge unit 46 and the ratio of the flow rate of air discharged from the fiber waste discharge unit 46 to the flow rate of air discharged from the air discharge unit 50 was evaluated. It is to be noted that, since the role of the air discharge unit 50 is to discharge the air obtained after having been separated from the fiber waste to an outside air, the inner diameter e of the air discharge unit 50 is fixed at 48 mm, for example. While results of the experiment are not shown in the figures, the flow rate (absolute value) of air in a Y-direction at a negative side in the fiber waste discharge unit 46 increases as the inner diameter h of the fiber waste discharge unit 46 increases and decreases as the inner diameter h of the fiber waste discharge unit 46 decreases. On the other hand, the air flow rate (absolute value) in a Y-direction at a positive side at the air discharge unit 50 tends to decrease as the inner diameter h of the fiber waste discharge unit 46 increases and tends to increase as the inner diameter h of the fiber waste discharge unit 46 decreases. As described above, according to the findings by the present inventors, the inner diameter h of the fiber waste discharge unit 46 is preferably smaller than the inner diameter e of the air discharge unit 50. However, when the inner diameter h of the fiber waste discharge unit 46 is 27 mm or less, the present inventors found that it is difficult to discharge the fiber waste from the fiber waste discharge unit 46. It is to be noted that, when the inner diameter h of the fiber waste discharge unit 46 is 27 mm, the ratio of the flow rate of air discharged from the air discharge unit 50 to the flow rate of air discharged from the fiber waste discharge unit 46 is approximately 7:3. This ratio decreases as the inner diameter h of the fiber waste discharge unit 46 increases. For example, when the inner diameter h of the fiber waste discharge unit 46 is in a range from 27 mm to 35 mm, as the inner diameter h of the fiber waste discharge unit 46 increases, the ratio of the flow rate of air discharged from the air discharge unit 50 to the flow rate of air discharged from the fiber waste discharge unit 46 decreases. Additionally, the present inventors found that when the inner diameter h of the fiber waste discharge unit 46 is 35 mm, the ratio of the flow rate of air discharged from the air discharge unit 50 to the flow rate of air discharged from the fiber waste discharge unit 46 is approximately 1:1. As described above, as the ratio of the flow rate of air discharged from the fiber waste discharge unit 46 to the flow rate of air discharged from the air discharge unit 50 increases, separation between the fiber waste and air does not become more favorable, and hence the inner diameter h of the fiber waste discharge unit 46 is preferably 35 mm or less.

[0085] EXPERIMENTAL EXAMPLE 1, EXPERIMENTAL EXAMPLE 2 and EXPERIMENTAL EXAMPLE 3 are the results when doing experiments using a 75 denier false-twisted fiber as described above, but the present inventors also conducted similar verifications on other fibers. The results of these experiments indicate that, for a false-twisted fiber, a polyester fiber, and a polyamide fiber, forming the inclined portion 44 in a tapered shape having an angle formed with a vertical direction of 7° to 10° (inclusive of upper and lower limits) made it possible to accurately separate the fiber waste and air and prevented the fiber waste discharge unit 46 from being clogged with the fiber waste, which allowed the fiber waste to be satisfactorily discharged from the fiber waste discharge unit 46. Significant results were found particularly for a 75 to 450 denier false-twisted fiber, a 150 denier PET, and nylon.

[MODIFIED EXAMPLES]

[0086] Embodiments of the present invention have been described above, but the present invention is not limited to the above-described embodiments and may be subject to various changes within the scope of the claims. For example, the present invention can be changed in the following manner.

[0087] In the above-described embodiment, the cyclone separator 30 corresponding to each of the fiber waste transfer pipes 11 (11a to 11d) is provided between each of the plurality of fiber waste transfer pipes 11 (11a to 11d) and one fiber waste collection unit 13, but no limitation is intended. For example, any one of the aspects according to the first to third modified examples can be adopted.

[FIRST MODIFIED EXAMPLE]

[0088] FIG. 9 is a schematic view showing a fiber waste collection device 1A according to a first modified embodiment of the present invention. As shown in FIG. 9, in the first modified example, the fiber waste collection device 1A includes a plurality of fiber waste collection units 13 (13a to 13d) and a plurality of cyclone separators 30 (30a to 30d) for each of a plurality of fiber waste transfer pipes 11 (11a to 11d).

[0089] More specifically, the fiber waste collection unit 13 includes a first fiber waste collection unit 13a corresponding to the first fiber waste transfer pipe 11a, a second fiber waste collection unit 13b corresponding to the second fiber waste transfer pipe 11b, a third fiber waste collection unit 13c corresponding to the third fiber waste transfer pipe 11c, and a fourth fiber waste collection unit 13d corresponding to the fourth fiber waste transfer pipe 11d. Further, the cyclone separator 30 (30a to 30d) includes a first cyclone separator 30a provided between the first fiber waste transfer pipe 11a and the first fiber waste collection unit 13a, a second cyclone separator 30b provided between the second fiber waste transfer pipe 11b and the second fiber waste collection unit 13b, a third cyclone separator 30c provided between the third fiber waste transfer pipe 11c and the third fiber waste collection unit 13c, and a fourth cyclone separator 30d provided between the fourth fiber waste transfer pipe 11d and the fourth fiber waste collection unit 13d. The first to fourth fiber waste transfer pipes 11a to 11d are each connected to a body portion (no reference sign) such that their longitudinal direction follows an inner peripheral wall (no reference sign) of the body portion (no reference sign) of the cyclone separator 30. In other words, similar to the fiber waste transfer pipes 11 (11a to 11d) described with reference to FIG. 5, in a plan view, the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are connected to the body portion of the cyclone separator 30 (30a to 30d) so as to be tangent to a tubular portion of the body portion of the cyclone separator 30 (30a to 30d).

[0090] Even with the aspect described in the first modified example, the fiber waste can be satisfactorily separated from air, the fiber waste can be satisfactorily discharged from the fiber waste discharge unit 46 (see FIG. 4), and the air separated from the fiber waste can be satisfactorily discharged from the air discharge unit 50 (see FIG. 4).

[SECOND MODIFIED EXAMPLE]

[0091] FIG. 10 is a schematic view showing a fiber waste collection device 1B according to a second modified embodiment of the present invention. As shown in FIG. 10, in the second modified example, the fiber waste collection device 1B includes a plurality of fiber waste transfer pipes 11 (11a to 11d), one fiber waste collection unit 13, and one cyclone separator 30.

[0092] The cyclone separator 30 is provided between the plurality of fiber waste transfer pipes 11 (11a to 11d) and the fiber waste collection unit 13. The plurality of fiber waste transfer pipes 11 (11a to 11d) merge on the upstream side of the cyclone separator 30 and are connected to a body portion (no reference sign) of the cyclone separator 30 such that the longitudinal direction of each pipe after merging follows an inner peripheral wall (no reference sign) of the body portion of the cyclone separator 30. In other words, similar to the fiber waste transfer pipes 11 described with reference to FIG. 5, in a plan view, the fiber waste transfer pipes 11 are preferably connected to the body portion such that the pipe after merging (no reference sign) is tangent to a tubular portion of the body portion of the cyclone separator 30.

[0093] Even with the aspect described in the second modified example, the fiber waste can be satisfactorily separated from air, the fiber waste can be satisfactorily discharged from the fiber waste discharge unit 46 (see FIG. 4), and the air separated from the fiber waste can be satisfactorily discharged from the air discharge unit 50 (see FIG. 4).

[0094] It is to be noted that, in the second modified example, all of the plurality of fiber waste transfer pipes 11 (11a to 11d) merge upstream of the one cyclone separator 30, but alternatively, a plurality of the cyclone separators 30 may be provided and two or more of fiber waste transfer pipes of the plurality of fiber waste transfer pipes 11 (11a to 11d) may merge upstream of the plurality of cyclone separators 30. For example, two fiber waste transfer pipes may merge upstream of one cyclone separator and be connected to one cyclone separator in the merged state, and another two fiber waste transfer pipes may merge upstream of another cyclone separator and be connected to the other cyclone separator in the merged state.

[THIRD MODIFIED EXAMPLE]

[0095] FIG. 11 is a plan view of a cyclone separator 30 according to a third modified embodiment of the present invention. FIG. 11 also shows an air discharge unit 50 for convenience. Similar to the fiber waste collection device 1B of the second modified example, the fiber waste collection device (no reference sign) according to the third modified example includes a plurality of fiber waste transfer pipes 11 (11a to 11d), one fiber waste collection unit (no reference sign), and one cyclone separator 30. It is to be noted that while the plurality of fiber waste transfer pipes 11 (11a to 11d) merge upstream of the cyclone separator 30 in the second modified example, in the third modified example, the plurality of fiber waste transfer pipes 11 (11a to 11d) are connected to one cyclone separator 30C instead.

[0096] More specifically, as illustrated in FIG. 11, in the third modified example, a first fiber waste transfer pipe 11a, a second fiber waste transfer pipe 11b, a third fiber waste transfer pipe 11c, and a fourth fiber waste transfer pipe 11d are connected at positions shifted in the circumferential direction of a body portion 32 of the one cyclone separator 30. The first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are each connected to the body portion 32 such that their longitudinal direction follows an inner peripheral wall 35 of the body portion 32 of the cyclone separator 30. In other words, similar to the fiber waste transfer pipes 11 described with reference to FIG. 5, in a plan view, the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are connected to the body portion 32 so as to be tangent to a tubular portion 34 of the body portion 32 of the cyclone separator 30. Even with the aspect described in the third modified example, the fiber waste can be satisfactorily separated from air, the fiber waste can be satisfactorily discharged from the fiber waste discharge unit 46, and the air separated from the fiber waste can be satisfactorily discharged from the air discharge unit 50.

[0097] It is to be noted that, the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d shown in FIG. 11 are all preferably connected to an upper portion of the body portion 32. However, not all of the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d need be provided at the same position in the up-and-down direction and some or all of the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d may be connected at positions shifted in the up-and-down direction.

[FOURTH MODIFIED EXAMPLE]

[0098] FIG. 12 is a perspective view of a cyclone separator 30 according to a fourth modified embodiment of the present invention. It is to be noted that FIG. 12 also shows an air discharge unit 50 for convenience. Similar to the fiber waste collection device 1B according to the second modified example, a fiber waste collection device (no reference sign) according to the fourth modified example includes a plurality of fiber waste transfer pipes 11 (11a to 11d), one fiber waste collection unit (no reference sign), and one cyclone separator 30.

[0099] As illustrated in FIG. 12, in the fourth modified example, a first fiber waste transfer pipe 11a, a second fiber waste transfer pipe 11b, a third fiber waste transfer pipe 11c, and a fourth fiber waste transfer pipe 11d are connected at positions shifted in the circumferential direction of a body portion 32 of the one cyclone separator 30. The first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are each connected to the body portion 32 such that their longitudinal direction follows an inner peripheral wall 35 of the body portion 32 of the cyclone separator 30. In other words, similar to the fiber waste transfer pipes 11 described with reference to FIG. 5, in a plan view, the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d are connected to the body portion 32 so as to be tangent to a tubular portion 34 of the body portion 32 of the cyclone separator 30. Even with the aspect described in the fourth modified example, the fiber waste can be satisfactorily separated from air, the fiber waste can be satisfactorily discharged from the fiber waste discharge unit 46, and the air separated from the fiber waste can be satisfactorily discharged from the air discharge unit 50.

[0100] It is to be noted that while the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d shown in FIG. 12 are connected to the body portion 32 at different positions in the up-and-down position but at the same position in the circumferential direction of the body portion 32, no limitation is intended. For example, some or all of the first fiber waste transfer pipe 11a to the fourth fiber waste transfer pipe 11d may be connected to the body portion 32 at different positions in the circumferential direction of the body portion 32.

[OTHERS]

[0101] In the embodiments described above, the fiber waste collection device 1 is a device installed in the false-twisting machine 101, but no limitation is intended. The fiber waste collection device 1 may be a device installed in a textile machine other than the false-twisting machine 101. For example, the fiber waste collection device 1 may be installed in a spinning machine.

[0102] In the embodiments described above, the winder 107 is described as being installed in the false-twisting machine 101 in which the winder 107 is provided in four stages in the up-and-down direction, but no limitation is intended. The winder 107 may be installed in a false-twisting machine 101 in which the winder 107 is provided in three or less stages or five or more stages in the up-and-down direction. In this case, the same number of fiber waste transfer pipes 11 as the number of winders 107 arranged in the up-and-down direction may be provided.

[0103] The above-described embodiment deals with a case in which a plurality of the fiber waste transfer pipes 11 are provided, but a different configuration may be adopted. An embodiment in which one fiber waste transfer pipe 11 is provided may also be adopted.

(Reference Numerals)

[0104]

1	Fiber waste collection device
11	Fiber waste transfer pipe
13	Fiber waste collection unit
15	Suction unit
30	Cyclone separator
32	Body portion
42	Tapered portion
44	Inclined portion
46	Fiber waste discharge unit
50	Air discharge unit
Y	Fiber

Claims

1. A false-twisting machine (101) comprising a fiber waste collection device (1) configured to collect fiber waste, the fiber waste collection device (1) including:

a fiber waste transfer pipe (11) arranged with a plurality of suction units (15) for suctioning the fiber waste generated in the false-twisting machine (101) such that the fiber waste suctioned from the plurality of suction units (15) is transferred along with air through the fiber waste transfer pipe (11);
a fiber waste collection unit (13) for collecting therein the fiber waste transferred through the fiber waste transfer pipe (11);

a cyclone separator (30) arranged between the fiber waste transfer pipe (11) and the fiber waste collection unit (13) configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe (11) so as to collect the separated fiber waste in the fiber waste collection unit (13); and
an air discharge unit (50) connected to the cyclone separator (30) for discharging the air obtained after having been separated from the fiber waste,
wherein the fiber waste transfer pipe (11) includes a plurality of fiber waste transfer pipes (11), and
the cyclone separator (30) includes a plurality of cyclone separators (30) each arranged to each of the plurality of fiber waste transfer pipes (11).

2. A false-twisting machine (101) comprising a fiber waste collection device (1) configured to collect fiber waste, the fiber waste collection device (1) including:

a fiber waste transfer pipe (11) arranged with a plurality of suction units (15) for suctioning the fiber waste generated in the false-twisting machine (101) such that the fiber waste suctioned from the plurality of suction units (15) is transferred along with air through the fiber waste transfer pipe (11);
a fiber waste collection unit (13) for collecting therein the fiber waste transferred through the fiber waste transfer pipe (11);
a cyclone separator (30) arranged between the fiber waste transfer pipe (11) and the fiber waste collection unit (13) configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe (11) so as to collect the separated fiber waste in the fiber waste collection unit (13); and
an air discharge unit (50) connected to the cyclone separator (30) for discharging the air obtained after having been separated from the fiber waste,
wherein the fiber waste transfer pipe (11) includes a plurality of fiber waste transfer pipes (11), and
the fiber waste collection unit (13) is arranged in a number smaller than a number of the plurality of fiber waste transfer pipes (11).

3. The false-twisting machine (101) as claimed in claim 1 or 2, wherein

the cyclone separator (30) includes a fiber waste discharge unit (46) for discharging the fiber waste to the fiber waste collection unit (13), and
the air discharge unit (50) is adjusted so as to discharge the air whose flow rate is larger than a flow rate of air discharged from the fiber waste discharge unit (46).

4. The false-twisting machine (101) as claimed in any one of claims 1 to 3, wherein
the air discharge unit (50) has a lower end portion (50a) arranged above the fiber waste transfer pipe (11).

5. The false-twisting machine (101) according to any one of claims 1 to 4, wherein
the air discharge unit (50) is arranged so as not to be within an interior of the cyclone separator (30) while an interior of the air discharge unit (50) communicating with an interior of the cyclone separator (30).

6. A fiber waste collection device (1) comprising:

a fiber waste transfer pipe (11) arranged with a plurality of suction units (15) for suctioning fiber waste such that the fiber waste suctioned from the plurality of suction units (15) is transferred along with air through the fiber waste transfer pipe (11);
a fiber waste collection unit (13) for collecting therein the fiber waste transferred through the fiber waste transfer pipe (11);
a cyclone separator (30) arranged between the fiber waste transfer pipe (11) and the fiber waste collection unit (13) configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe (11) so as to collect the separated fiber waste in the fiber waste collection unit (13); and
an air discharge unit (50) connected to the cyclone separator (30) for discharging the air obtained after having been separated from the fiber waste,
wherein the fiber waste includes a polyester fiber or a polyamide fiber, and
the cyclone separator (30) includes
a body portion (32) in a tubular shape connected with the fiber waste transfer pipe (11) such that a longitudinal direction of the fiber waste transfer pipe (11) follows an inner peripheral wall of the body portion (32), the body portion (32) configured to cause the fiber waste transferred through the fiber waste transfer pipe (11) to travel downward along the inner peripheral wall due to a centrifugal force,

a fiber waste transfer portion (42) connected to a lower portion of the body portion (32), and

a fiber waste discharge unit (46) for discharging the fiber waste separated from the air to the fiber waste collection unit (13),

wherein the fiber waste transfer portion (42) has an inclined portion whose diameter decreases from a point of connection with the body portion (32) toward the fiber waste discharge unit (46), and

the inclined portion is formed in a tapered shape having an angle formed with respect to a vertical direction within a range of larger than or equal to 7° and smaller than or equal to 10°.

7. The fiber waste collection device (1) as claimed in claim 6, wherein
the air discharge unit (50) is adjusted so as to discharge the air whose flow rate is larger than a flow rate of air discharged from the fiber waste discharge unit (46).

8. A fiber waste collection device (1) comprising:

a fiber waste transfer pipe (11) arranged with a plurality of suction units (15) for suctioning fiber waste such that the fiber waste suctioned from the plurality of suction units (15) is transferred along with air through the fiber waste transfer pipe (11);

a fiber waste collection unit (13) for collecting therein the fiber waste transferred through the fiber waste transfer pipe (11);

a cyclone separator (30) arranged between the fiber waste transfer pipe (11) and the fiber waste collection unit (13) configured to separate the fiber waste from the air transferred through the fiber waste transfer pipe (11) so as to discharge the separated fiber waste to the fiber waste collection unit (13); and

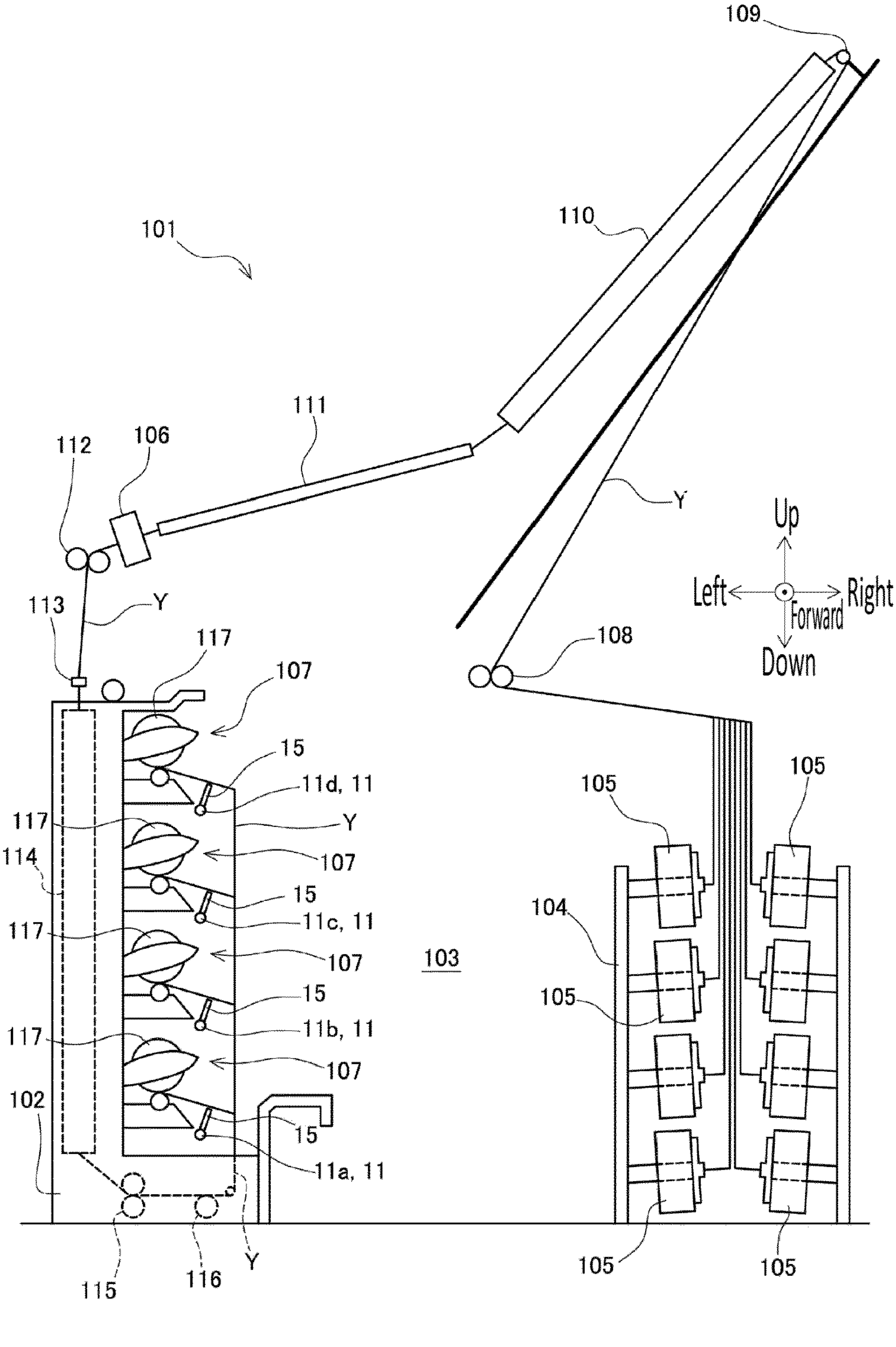
an air discharge unit (50) connected to the cyclone separator (30) for discharging the air obtained after having been separated from the fiber waste,

wherein the air discharge unit (50) is adjusted so as to discharge the air whose flow rate is larger than a flow rate of air discharged from the cyclone separator (30) to the fiber waste collection unit (13).

9. The fiber waste collection device (1) as claimed in any one of claims 6 to 8, wherein
the air discharge unit (50) has a lower end portion (50a) arranged above the fiber waste transfer pipe (11).

10. The fiber waste collection device (1) as claimed in any one of claims 6 to 9, wherein
the air discharge unit (50) is arranged so as not to be within an interior of the cyclone separator (30) while an interior of the air discharge unit (50) communicating with an interior of the cyclone separator (30).

FIG. 1


109
110
101
111
112
106
Y
Up
Left
Right
Forward
Down
113
117
107
108
15
11d, 11
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114
107
11c, 11
117
107
103
104
105
15
11b, 11
117
107
102
15
11a, 11
115
116
Y

FIG. 2

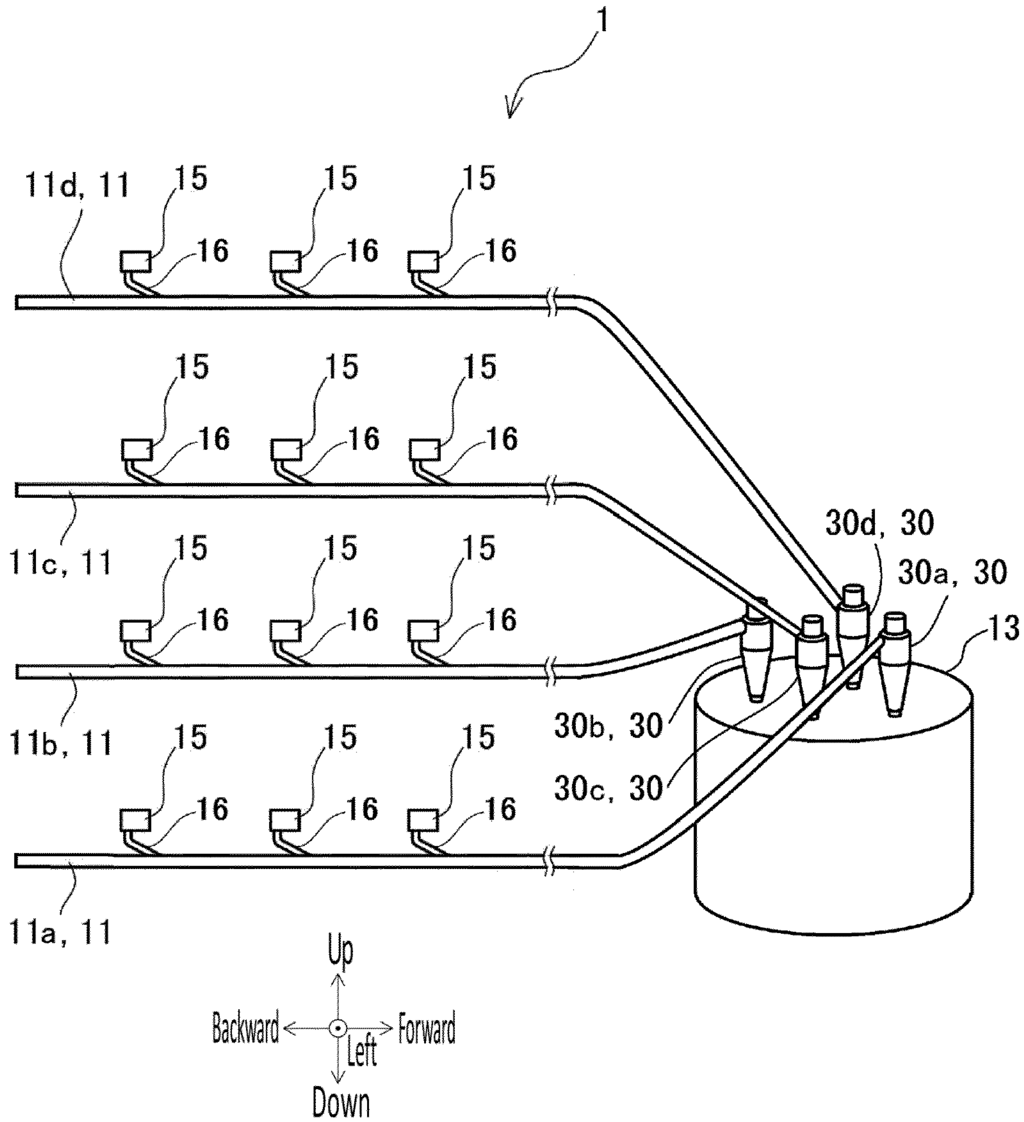

1
11d, 11
11c, 11
11b, 11
11a, 11
15
16
30d, 30
30a, 30
30b, 30
30c, 30
13
Up
Backward
Forward
Left
Down

FIG. 3

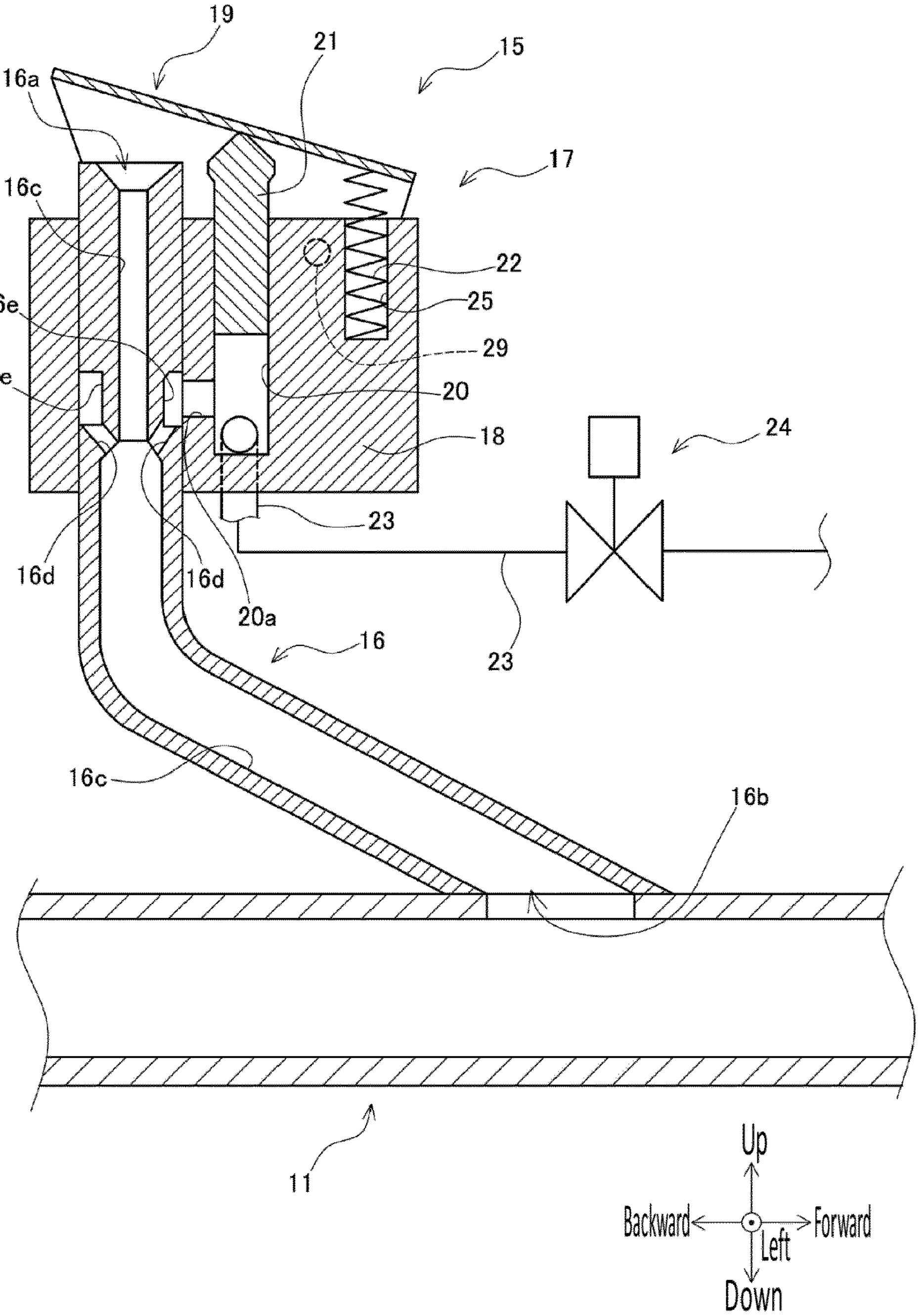

19
21
15
16a
17
16c
22
25
16e
29
16e
20
18
24
23
16d
16d
20a
23
16
16c
16b
11
Up
Backward
Forward
Left
Down

FIG. 4

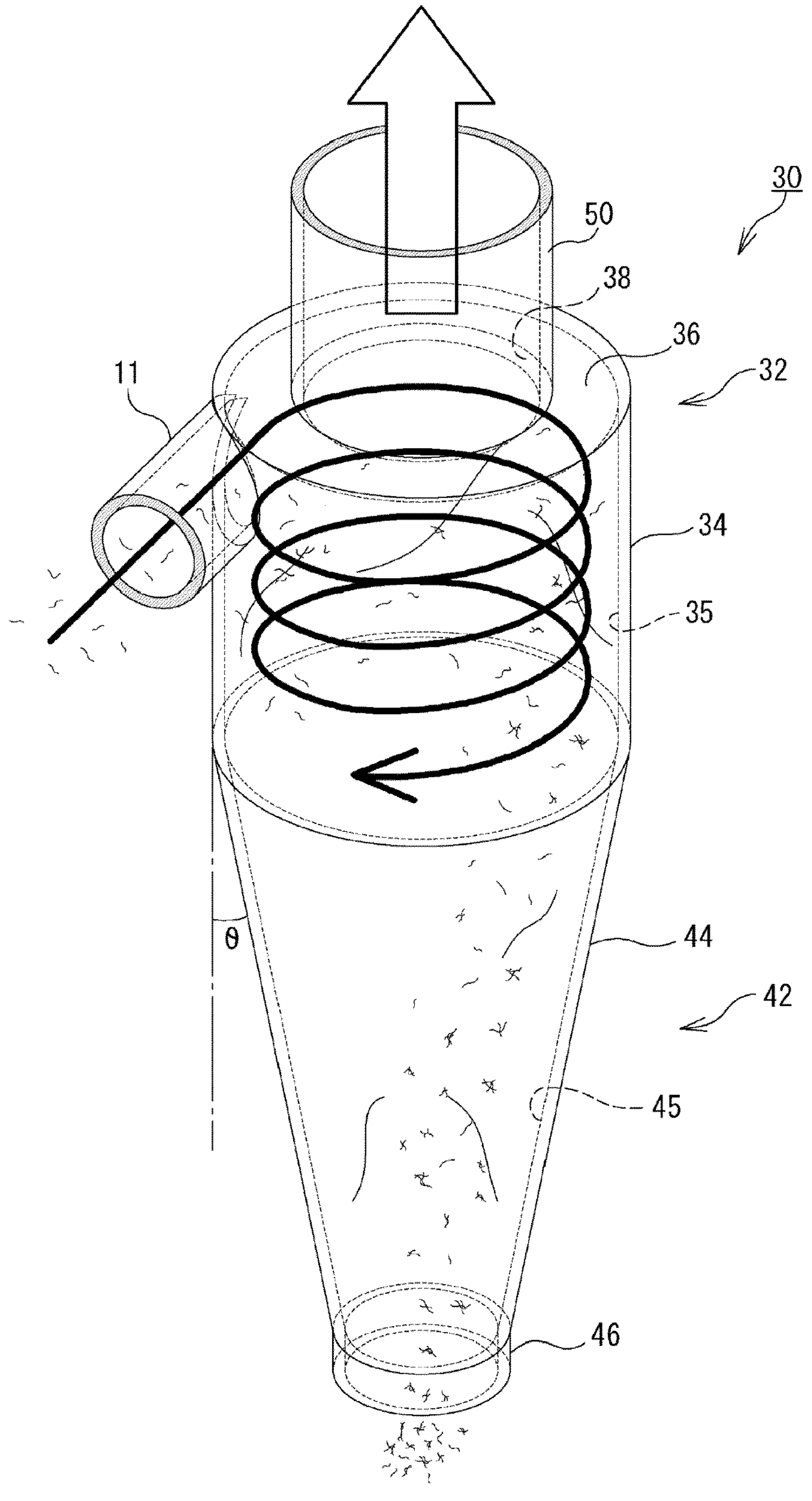


FIG. 5

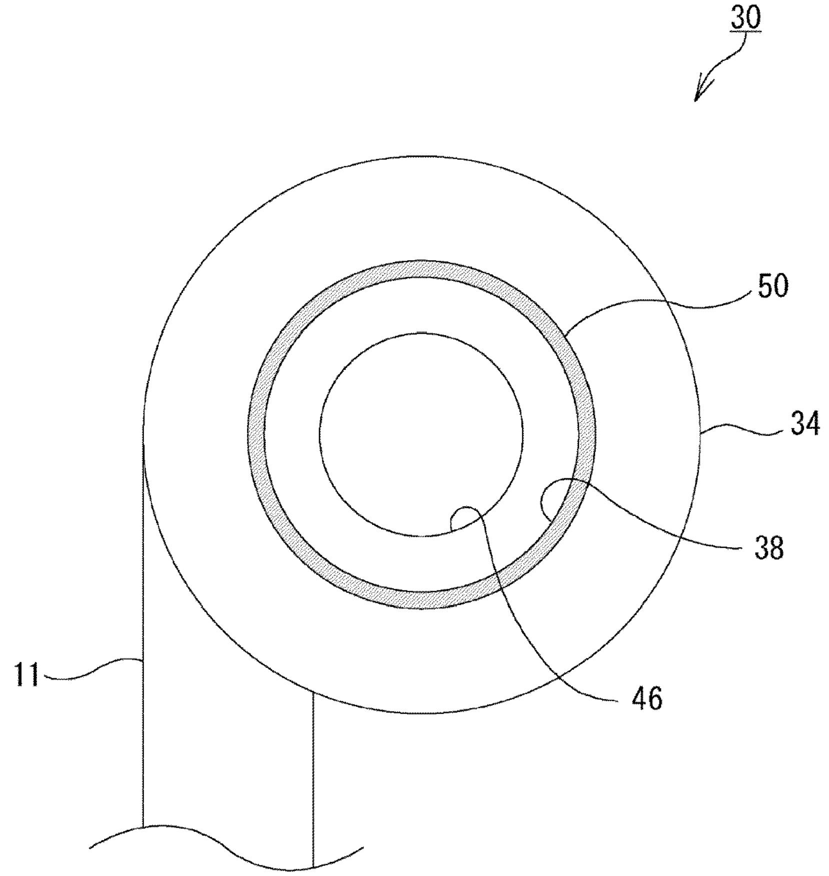


FIG. 6

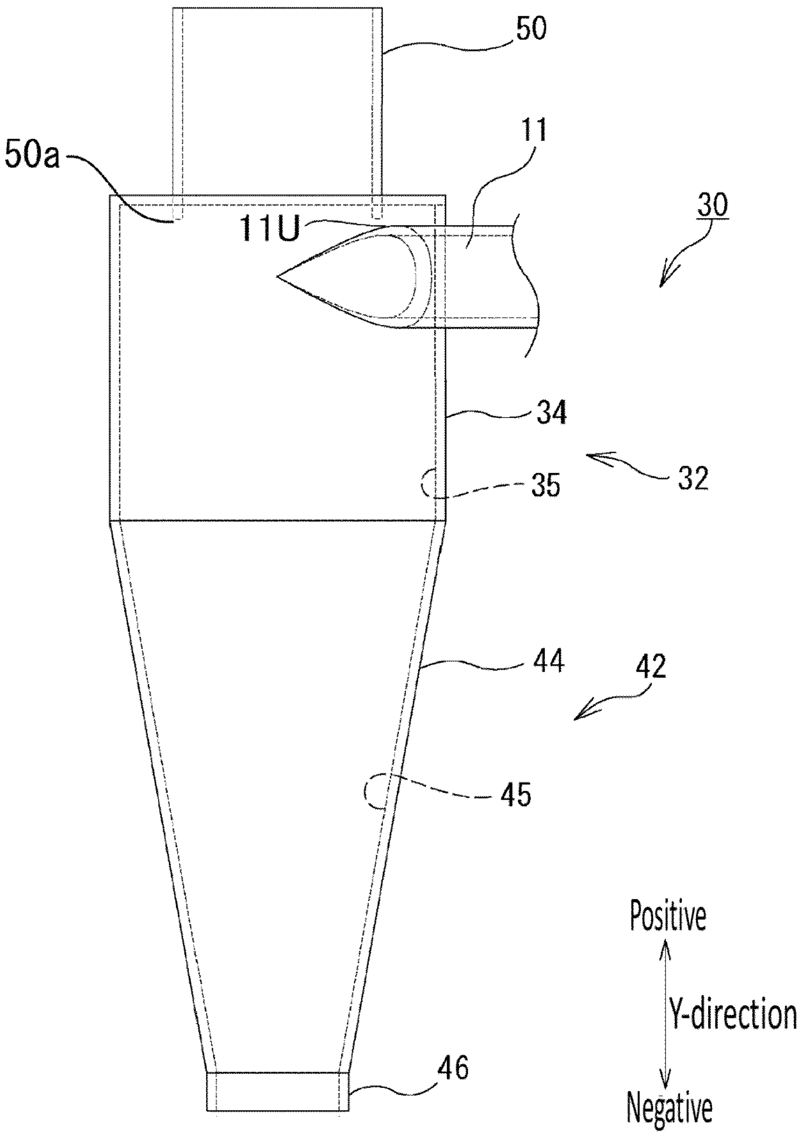

50
50a
11
11U
30
34
32
35
44
42
45
Positive
Y-direction
Negative
46

FIG. 7

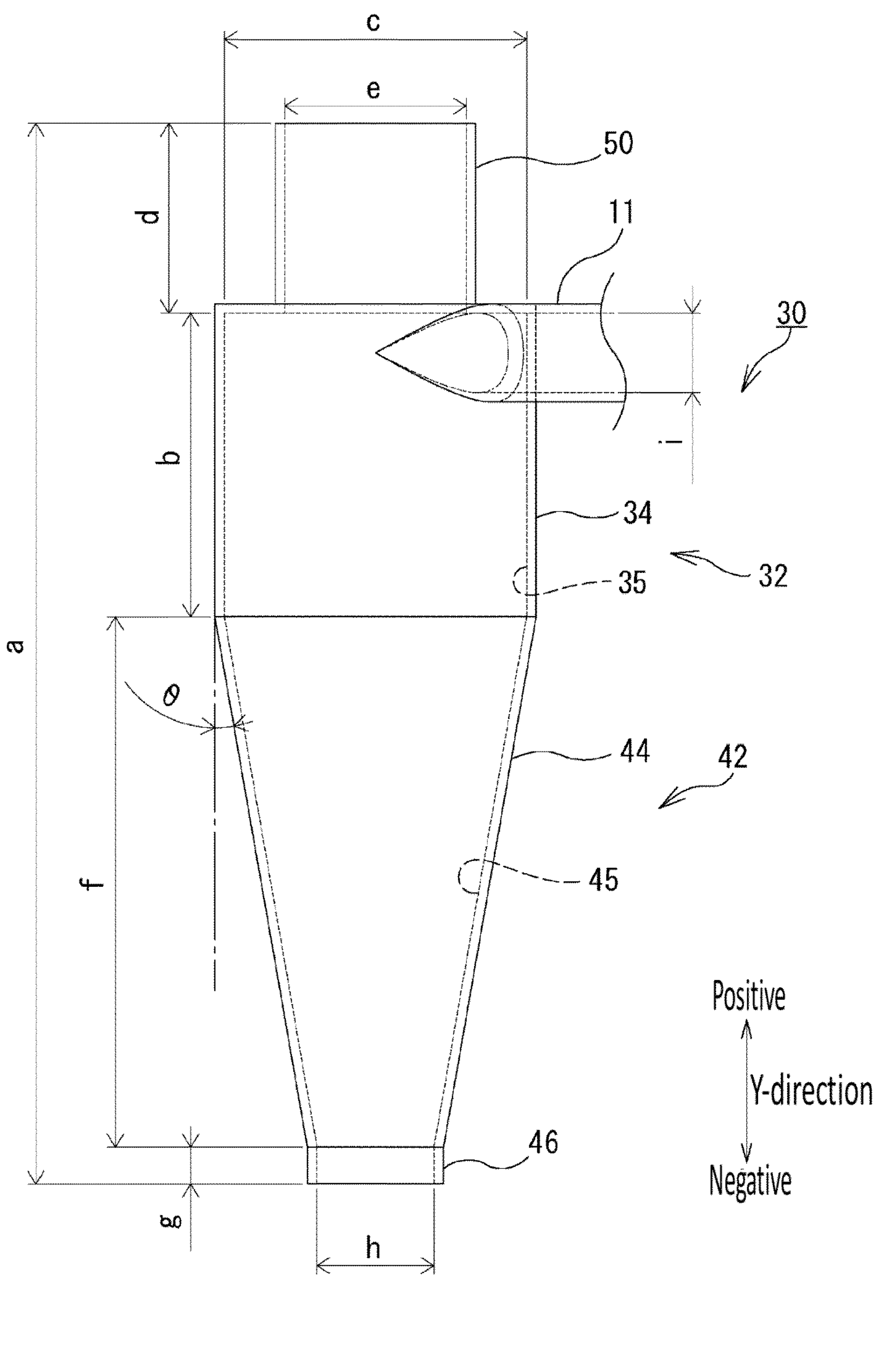

c
e
50
d
11
30
b
i
34
32
35
a
θ
44
42
f
45
Positive
Y-direction
Negative
46
g
h

FIG. 8

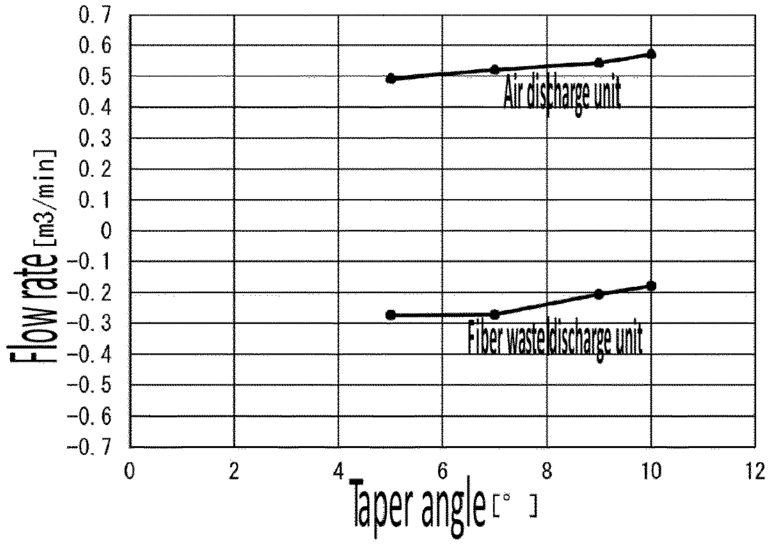
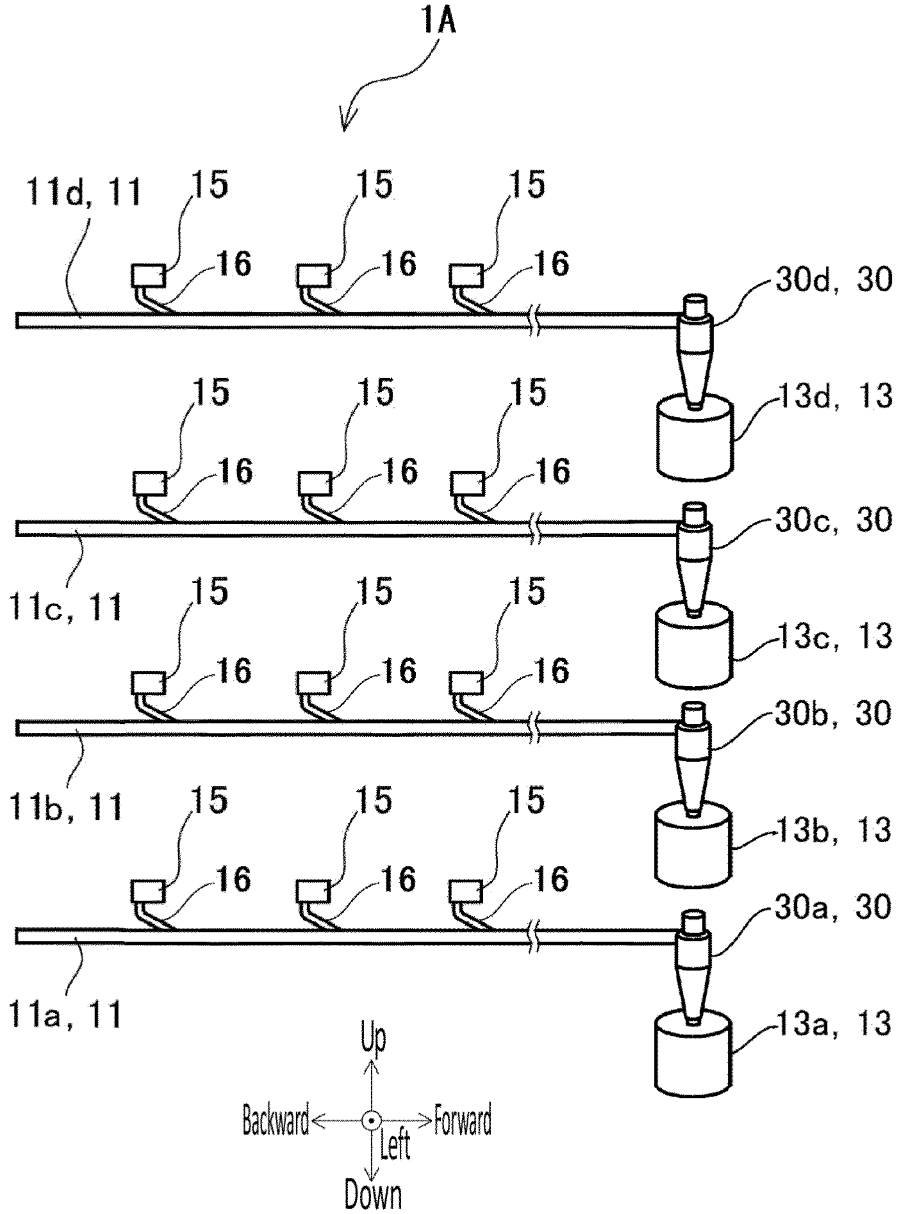

Flow rate [m3/min]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
0
2
4
6
8
10
12
Taper angle [°]
Air discharge unit
Fiber waste discharge unit

FIG. 9


1A
11d, 11
15
16
30d, 30
13d, 13
30c, 30
11c, 11
13c, 13
30b, 30
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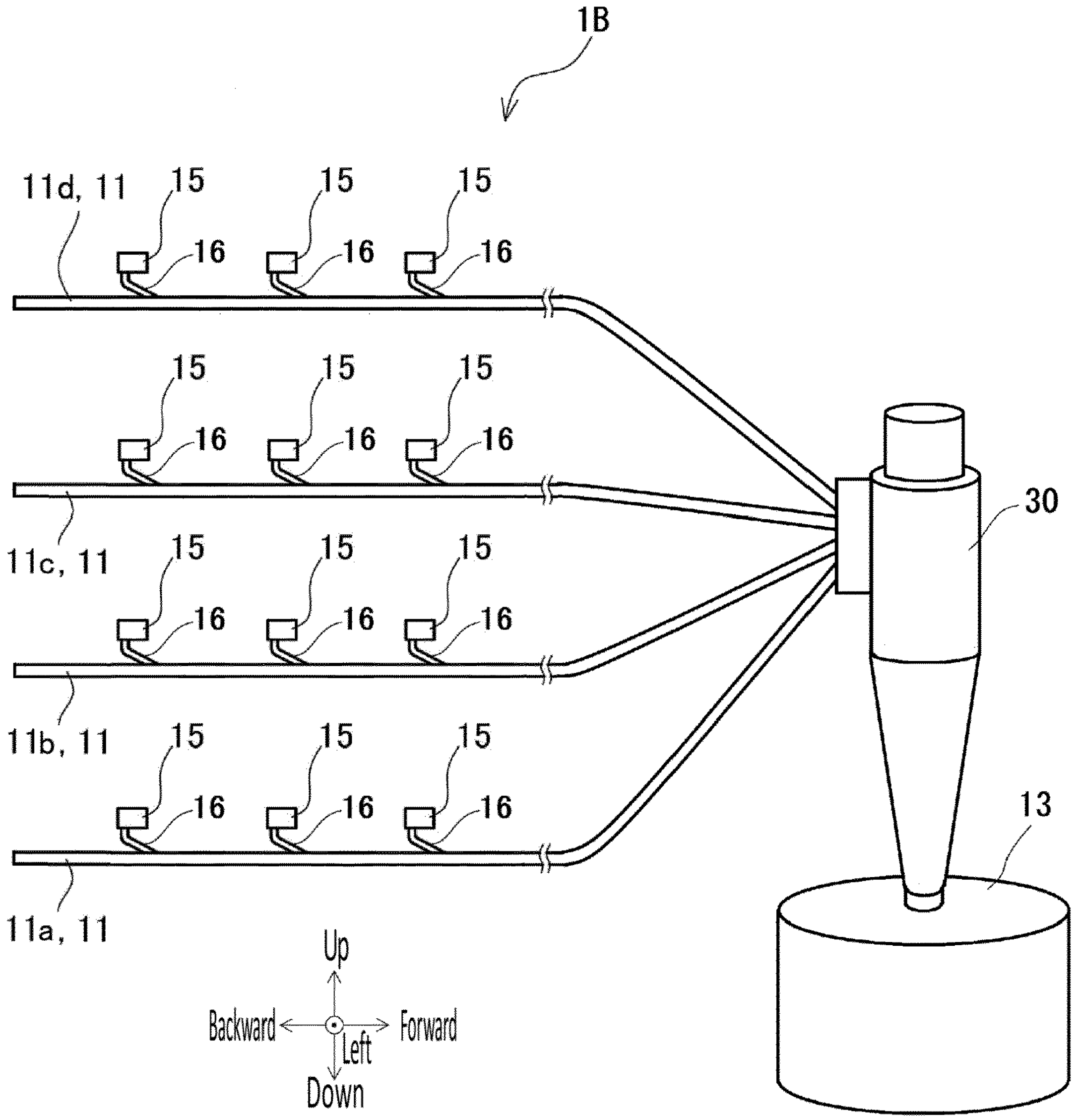
13b, 13
30a, 30
11a, 11
13a, 13
Up
Backward
Forward
Left
Down

FIG. 10


1B
11d, 11
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16
15
16
15
16
15
16
15
16
15
16
11c, 11
15
16
15
16
15
16
11b, 11
15
16
15
16
15
16
11a, 11
30
13
Up
Backward
Forward
Left
Down

FIG. 11

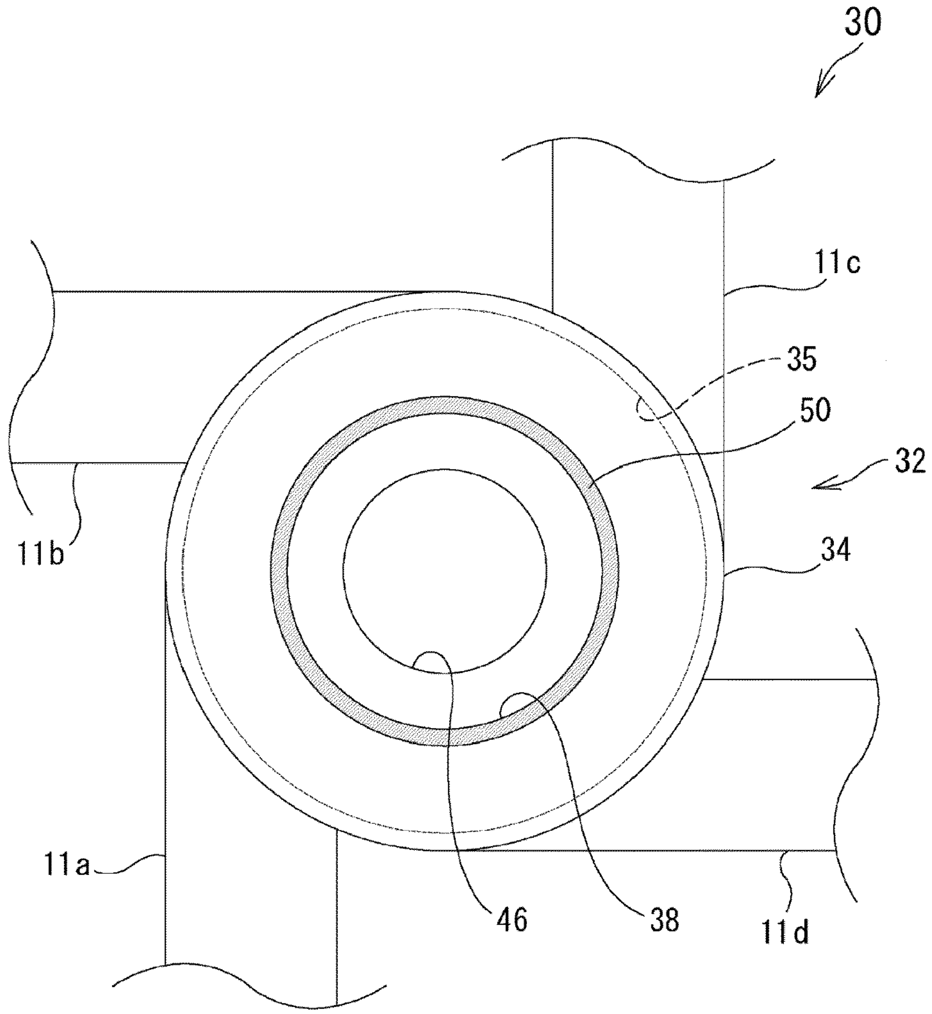
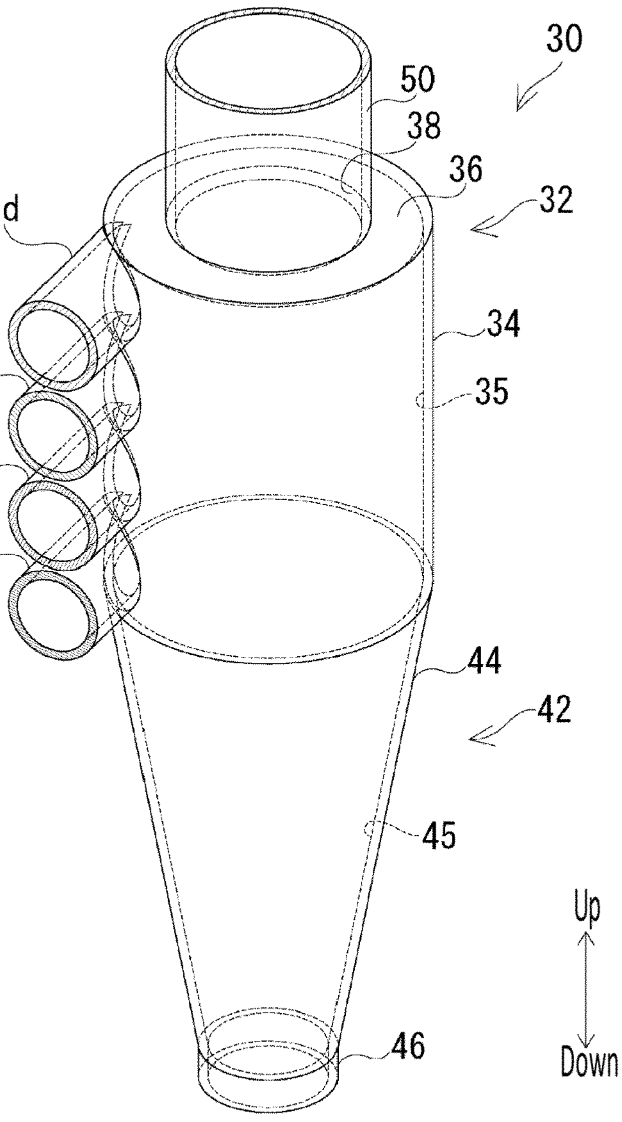


FIG. 12



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Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 19 9658

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 2005/049464 A1 (SAURER GMBH & CO KG [DE]; PYRA MICHAEL [DE]; WORTMANN THOMAS [DE]) 2 June 2005 (2005-06-02) * abstract; claims 1-10; figures 1-5 *	1-5	INV. D01H11/00 B65H54/70
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